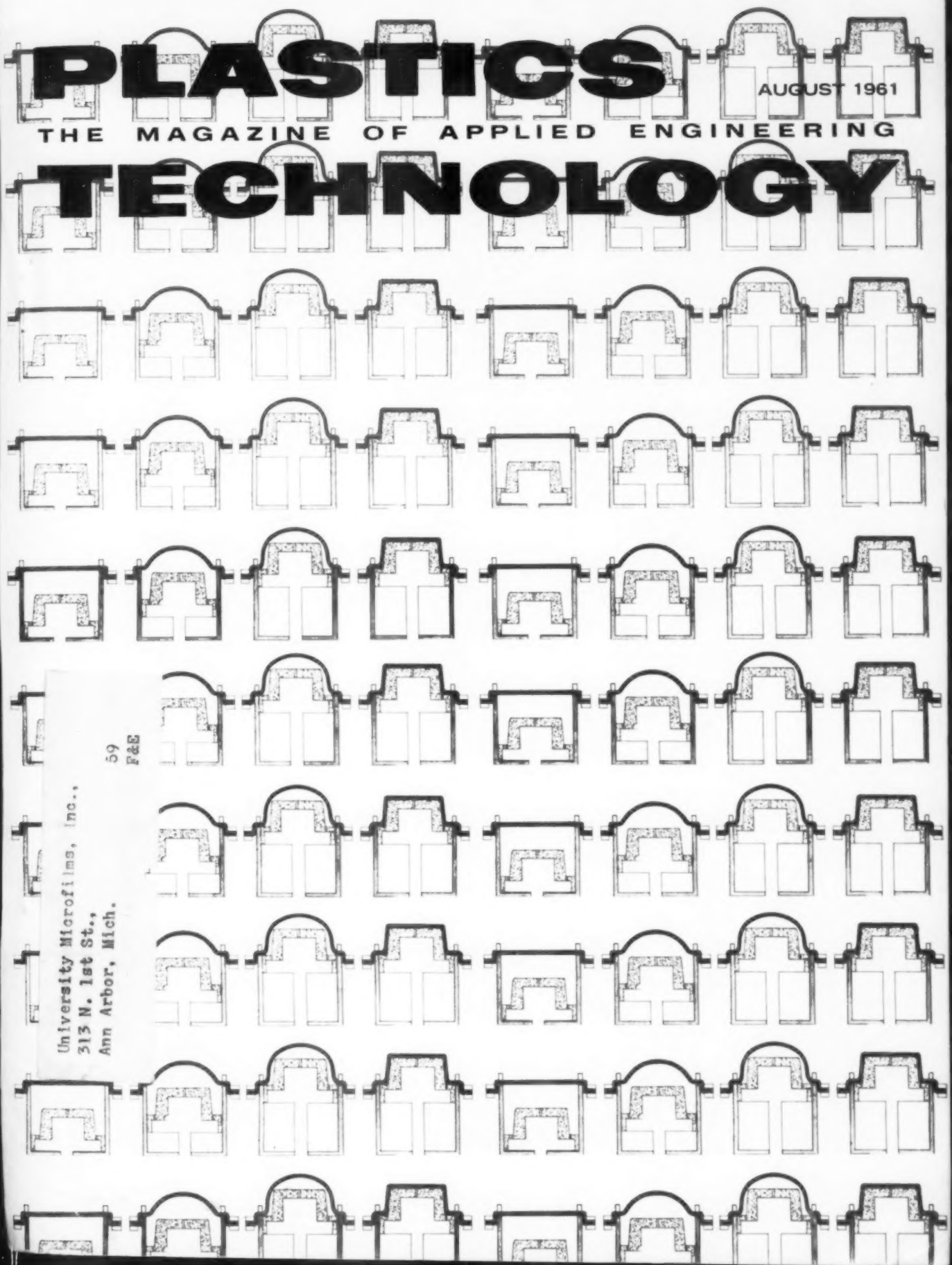
PLASTICS TECHNOLOGY

AUGUST 1961

THE MAGAZINE OF APPLIED ENGINEERING



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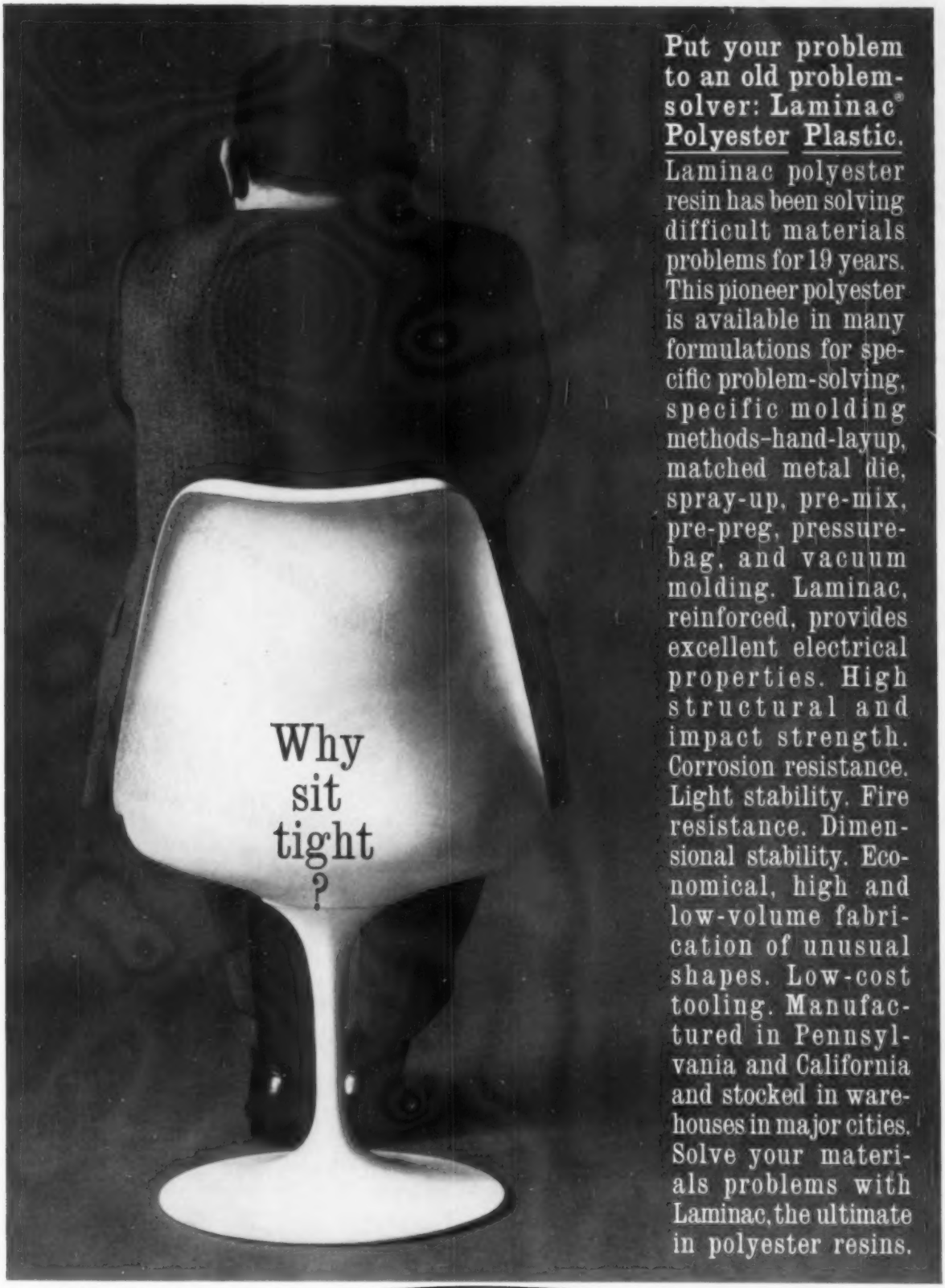

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PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

August 1961, Vol. 7, No. 8

feature articles

SHOULD I BUY A MOVABLE SCREW INJECTOR? **p.25**

by A. R. Morse

Shortcomings and limitations of the movable screw injector are pointed up, with emphasis on injection pressures. These are considered by the author to be inadequate for rapid and complete mold filling. Slow and costly cycles are the result. He feels that the screw is pretty much limited to very large parts and the more difficult materials such as nylon, vinyl, acetals, and polycarbonates.

REACTION MECHANISMS, CHEMICAL STRUCTURES, AND CHANGES IN PROPERTIES DURING THE CURING OF EPOXY RESINS **p.28**

by W. Fisch and W. Hofmann

New analytical methods disclose certain correlations between the chemical composition of a cured epoxy resin and its physical properties. Control of the exothermic reaction during cure of large castings results in low shrinkages.

WHAT'S WRONG WITH MACHINE INSTRUCTION MANUALS? . . . **p.33**

by I. I. Rubin

One of the trickiest problems to solve in writing an article, report, or text is knowing your reader—his capabilities and limitations. Instruction manuals are all too often pointed at the wrong audience. Operating and maintenance personnel are not design engineers, yet they are expected to interpret vague generalities about complex equipment. A suggested machine manual and its inclusions are described.

THERMOFORMING — PROCESSES AND APPLICATIONS **p.36**

by J. R. Lynch

The unique features of thermoforming are pointed out—those which make it ideal for certain applications and those which restrict its use in other applications. Thermoforming should certainly be looked into by any processor seeking new applications for plastics.

engineering forum

THE CONSCIENTIOUS SALESMAN **p.43**

Paul E. Fina, Engineering Forum Editor

This month's Compression & Transfer Molding column discusses the aims and problems of the plastics salesman.

exploring fabrication techniques

EXTRUDING RIGID BOOKBINDERS, MAGNETS IN INJECTION MOLDING **p.46**

Lee J. Zukor, Engineering Editor

A method of producing one-piece, semi-rigid loose leaf binders self-hinged at the folds is described along with a technique for holding steel inserts in injection molded parts by means of magnets.

Cover: Courtesy Dow Chemical Company

Departments

4 Letters to the Editors
5 On Schedule
14 What's New In Processing
17 Editorial
45 News of the Industry
51 Names in the News
52 New Materials
57 New Equipment
60 Plastics Applications
66 New Literature
67 Book Reviews
68 Article Abstracts
70 Calendar of Coming Events
71 Production & Sales
72 Current Market Prices

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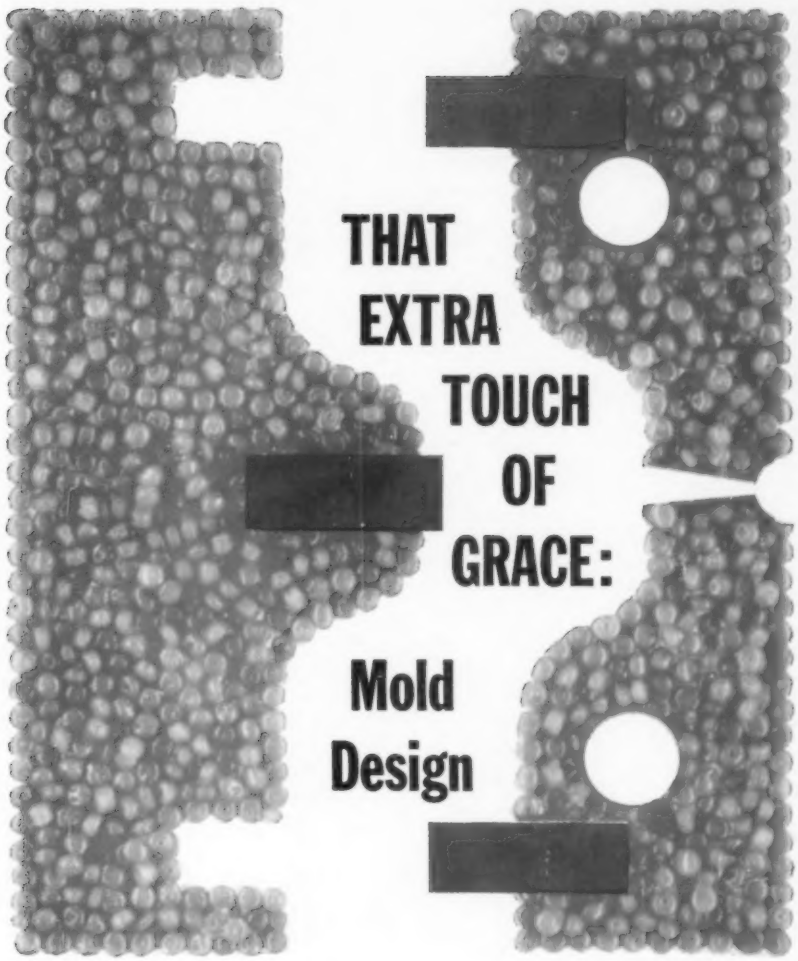

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Letters to the editors

Sirs:

Your attention is called to a small error in my article, "A Micro-Flo Melt Indexer," in the May 1961 issue.

Paragraph 4 under Operating Procedures should read in part: "The relationship was linear, and passed through the origin; the conversion factor was 6.51."

R. E. Wiley
U. S. Industrial Chemicals Co.
Tuscola, Ill.

Sirs:

We are looking for a source of supply of continuous plastic (piano) hinge which is 1½ inches wide when open. We have written to a number of companies . . . but so far have been unsuccessful in obtaining any information.

Do you know of any company who might handle this product?

L. K. Mueller, President
Activ-Ad, Inc.
21 S. Erie St.
Toledo 2, O.

(Anyone interested in supplying this hinge can write to us or directly to Mr. Mueller.—Ed.)

Sirs:

In the January 1961 issue of your magazine in an article written by Don B. Semeyn of Dow Chemical Co., we would like to correct a slight error in the paragraph on Tote Bins.

Don points out that the bins they are using in their Midland warehouse hold 2700 pounds of plastic material and through oversight neglected to mention that we do have larger Tote Bins available that will handle 4000 pounds of material. Since 26 bins can be carried on a special container car, you can easily get a full carload. The bins are moved free in both directions, so there is no problem in returning empties.

C. D. Ackerman
Tote System, Inc.
Beatrice, Neb.

Information wanted

Sirs:

Can you supply us with the names of manufacturers of the two-inch plastic telescopes used photographers to view transparencies?

Art-Line Photo Mount & Novelty Mfg. Co., Inc.
Brooklyn 3, N. Y.

Sirs.

I am interested in knowing if you have information regarding some company or companies who may be interested in the manufacture of plastic grass and plastic bed boards.

M. Kufferman
Miami 54, Fla.

(We will be glad to forward offerings and data to the interested parties.—Ed.)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

Articles on schedule

A Union Carbide article by E. E. Diez and H. G. Schaeffer on Prototypes and Mold Fabrication. It explains the techniques which are available, with special emphasis on the epoxy systems.

•

We have another article on tap by a mold maker and blow molder, T. Kaplan of Kapgo Plastics Corp. This article is concerned with some of the refinements which can be built into the finished mold.

•

The second part of J. R. Lynch's article on Thermoforming—Processes and Applications will appear in September. Unique features of the process are pointed out which make it ideal for certain applications, while restricting its use in others. Interest in thermoforming is being considerably revived, especially with some of the newer automatic equipment currently available.

•

Dale Amos of Amos-Thompson Corp. discusses the future of custom molding. He feels that custom molders face a very serious problem and would do well to consider adding proprietary items. In so doing, they should watch out for another trend which is appearing—the growth of captive molding among their customers.

•

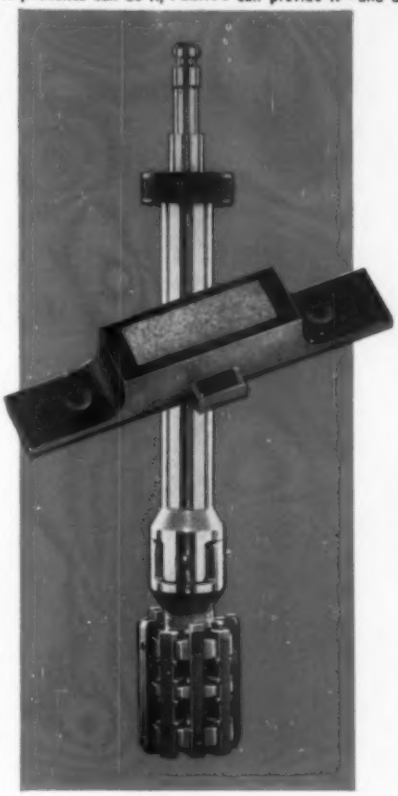
A staff written article which surveys the opinions of extruders and extruder manufacturers as to what is significant in 1961, what is needed, what can be expected in the near future, and any other accompanying problems.

•

In November, we will run the tabulations on 1961 extruders. This will be an updating of the tabulations which appeared in September of 1960, which was postponed two months because of the Plastic Show.

•

If phenolics can do it, PLENCO can provide it—and does—for **MICROMATIC HONE CORPORATION**

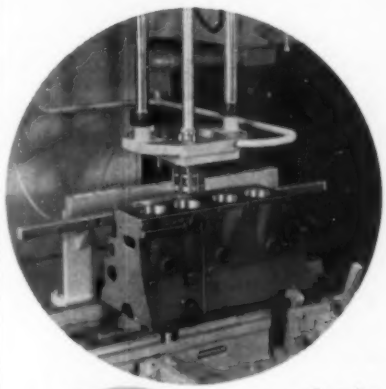


this is the holder
(MOLDED WITH PHENOLICS)

that grips the "stone"
(THE ABRASIVE CUTTING-SURFACE)

that puts the hone
(THE ULTRA-PRECISION TOOL)

in **Micromatic Microhoning**
(THE CONTROLLED ABRADING PROCESS)



One of the most efficient methods devised for the removal of stock from internal and external cylindrical surfaces is the modern *Microhoning* process, developed by Micromatic Hone Corporation, Detroit, Mich. Control is so positive and results so precise that geometric tolerances to within .0001 of an inch are obtainable.

A key to this performance excellence is the abrading surface or "stone"—fitted precisely and gripped securely by its molded holder. When *Plenco* phenolics are specified as the molding material, it is on the basis of the compound's adaptability to a range of abrasive grades, and its uniform flow, *uniform shrinkage*, assured dimensional stability.

Ready-made or custom-formulated, Plenco molding compounds meet the critical demands of industry in countless, varied applications. Please feel free to consult with our staff about *your* molding problem.

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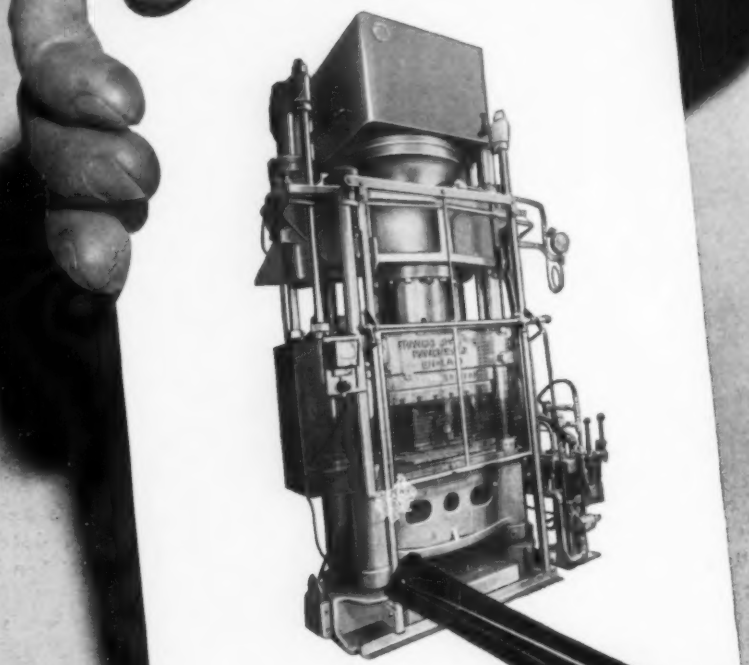

Francis Shaw hydraulic presses are tailor-made to requirements of the rubber and plastics industries. Illustrated is a 300-ton press recently installed. Shaw presses include the following design features:

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OVERSEAS AGENTS THROUGHOUT THE WORLD

P4451

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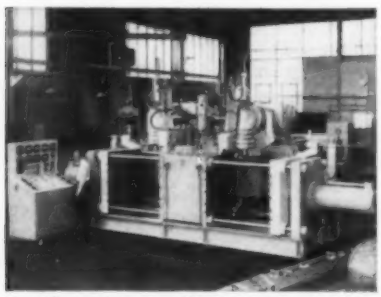
U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

Packaging Notes

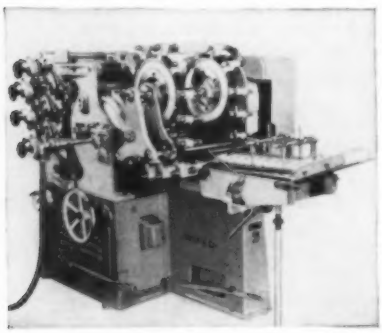
Pressure-sensitive polyethylene tape sustains its tack and flexibility throughout a temperature range of -50° F to 225° F. It's stretchable, conforms to most surfaces to which it is applied, resists water and many chemicals. The bond between the permanent adhesive backing and the four-mil polyethylene surface is said to be excellent. Potential applications of the new, high-tack tape include freezer packaging, closure and sealing of plastic covers and liners, drums and bags.

Giant blow molding equipment turns out thin-wall drum liners of polyethylene at the rate of 120 to 150 per hour. The two-station prototype illustrated has produced containers up to 80 gallons in capacity; is considered capable of blowing objects twice the size without difficulty. Molds operate alternately.



New blow molding machine has produced objects 15 to 80 gallons in size, including 55-gallon drum liners made of U.S.I.'s PETROTHENE 106 polyethylene resin.

Automatic bottle printing machine developed in Switzerland is now being distributed in the U. S. It prints in dry offset—up to four colors in a single operation. Handles cylindrical polyethylene bottles with a diameter range of one to four inches and a printing length of 8¼ inches; or, bottles up to approximately five inches in diameter without printing the whole circumference. Maximum output: 2500 per hour.



U. S. I. Predicts New FDA Ruling Will Spur Food Packaging Use Of Polyethylene

Broader Acceptance of Film, Laminates and Molded Containers Anticipated

The Food and Drug Administration's recent approval of specification-grade polyethylene for food packaging is expected to result in significantly greater use of this versatile plastic. Explains William P. Marsh, Jr.,

Effects of FDA's regulation approving specification-grade polyethylene as a food packaging material will soon be reflected in supermarkets across the country. Sharp rise in polyethylene-packaged meats and dairy products is foreseen.

Vice President and Assistant General Manager of Chemical Operations, U. S. Industrial Chemicals Co.: "Although polyethylene has been sold as a food packaging material for some time, many processors have preferred to await FDA's position before investing in development and equipment.

"With approval granted, we look to polyethylene's natural advantages to be put to substantially increased use for packaging butter, cheese, cream and other dairy products—as well as for both fresh and frozen meats. It's just the stimulus needed to spark considerably higher sales in this major market."

Mr. Marsh feels the rise in polyethylene food packaging will be immediately apparent and will have several forms: film; board, foil and cellophane laminates; molded cups; and vacuum-processed containers.

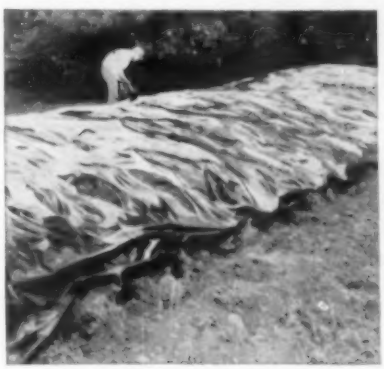
ALL U.S.I. PETROTHENE® polyethylene resins made for food packaging applications fully comply with the new FDA regulations.

Silage Protected by 7-mil Green Polyethylene Film

Trench and bunker silo covers of new 7-mil green polyethylene film are providing better storage conditions than upright silos—at a fraction of the cost. The green pigmentation helps ward off harmful ultraviolet sun rays and is pleasing to the eyes. Furthermore, the film guards against oxygen attack on silage nutrients and still allows for escape of excess gases which form during storing. The 7-mil thickness provides strength for serviceability and long life.

U.S.I.'s PETROTHENE polyethylene is used in the production of the covers. Explains the manufacturer: ". . . because no weak spots can be tolerated, we insist on resins of utmost reliability and uniformity."

The new film is also being used as ice rink liners and swimming pool covers.



Improved Mold Decorating Process Developed

Look for a new look in molded polyethylene products. A Youngstown, Ohio company reports a unique process said to make it possible to decorate even deep cavities of molds in almost any pattern of grain desired.

According to the announcement, "practically any design that can be drawn in line" can now be incorporated in either cavity and core molds for injection and blow molding or in dies for compression molding. To date the method has been used for houseware, automotive, TV and radio products.

Advantages claimed for decorating molded products: increases sales appeal; provides a durable, mar-resistant finish; offers functional improvements and economies to molders — such as air release for blow molding, etc. A lessening of static charges is also believed to result, but this has not yet been fully explored.

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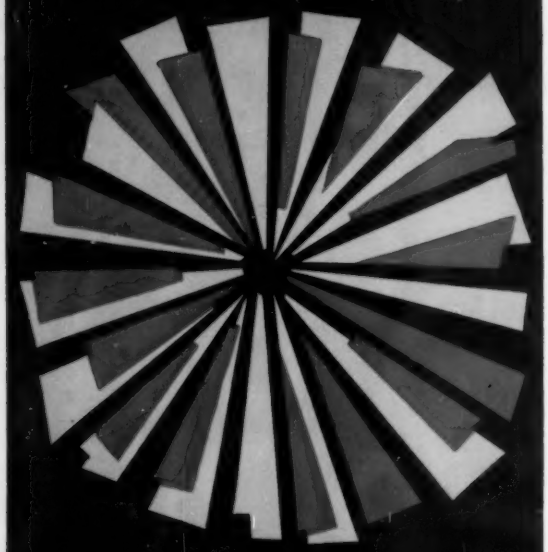

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You've never seen anything like the Hobbs "CHP" Winder. It's in a class by itself. No other winding device can match it for simplicity, efficiency and flexibility.

OPERATES ON A.C. Here is a squirrel cage three-phase A.C. motor, flange mounted to a gear reducer. It can be connected *directly* to your rewind shaft. It is entirely independent of the main machine drive. You plug it into your present three-phase power outlet – no transformers or converters to bother with. Then you set a knob to the desired tension and walk away.

AUTOMATICALLY SENSES TORQUE. From the start to the very finish of your rewind operation, the "CHP" accurately maintains the desired tension – protects even the most delicate materials from stretching, breaking or contracting. Automatically the "CHP" senses the increase in torque as the roll diameter builds up and it slows down the speed of the shaft in direct proportion. Controlled tension can be maintained in a roll build-up of as high as 10 to 1.

ECONOMICAL, FLEXIBLE. The efficiency of the "CHP" is many times greater than that of other types of winders. Maintenance is as slight as with any normal A.C. motor – there are no brushes or tubes. The "CHP" is compact, saves you floor space. It is clean, there are no belts to slip and stir up dirt. It is flexible – connect it directly to the rewind shaft, or remotely by chain and sprockets. And it needs no supervision, saves you labor costs.

MULTIPLE APPLICATIONS. The "CHP" Winder has already proved its adaptability and efficiency in multiple applications: – for winding, unwinding and inspection of paper, plastics, rubber and woven and non-woven textiles in a wide range of widths and weights.

Find out for yourself just why the Hobbs "CHP" Winder can make such a big difference – how it can give you increased production through *positive* quality control. Mail coupon below for free information. No obligation.

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78H Salisbury St., Worcester 5, Mass.

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Pressure-temperature operation is here!

Research by Barber-Colman and cooperating members of the Plastics Industry has proved the practicality of pressure-temperature operation. Pressure indication speeds return to best mixing conditions and gives faster read-out of screw or screen troubles. Savings up to 1/3 have been reported by users. The new instruments below are specifically designed to aid plastics production. Ask your Barber-Colman Sales and Service Engineer today.

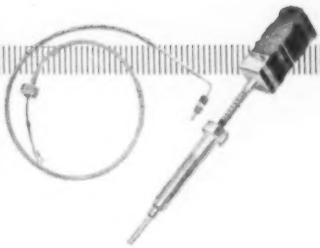
Record any combination of pressure and temperature up to 24 points

The new Series 8000 Multipoint Recorders are electronic potentiometer instruments with zero and span adjustment for the pressure range. Dual 11″ scales indicate temperature and pressure. Accuracy is ±¼ of 1% in typical ranges between 0-800°F and 0-10,000 psig. Zener diode constant voltage source. Up to six high or low limit switches. Swing-away chassis. Series 2000 Round Chart Recorders are available for r.p.m. or foot-per-minute control of plastic sheet roll units.

Now you can indicate temperature or pressure on only one instrument while controlling temperature. Simply flip the selector switch. The new Series 400 Capacitrol Indicators offer 6″ direct reading scale, and high or low limits.

Series 400 Capacitrols indicate and control temperatures. Available with Truline "anticipatory" time proportioning. Accurate 6″ scale . . . famed no-contact "Electronic Link"...plug-in chassis. Sensitive, accurate and reliable.

Specially designed for the plastics industry, Model 297 Capacitrols offer accurate "Electronic Link" and built-in anticipating control. Easy-to-read 5″ scale, plug-in components, compact size. Sensitive, dependable and economical.



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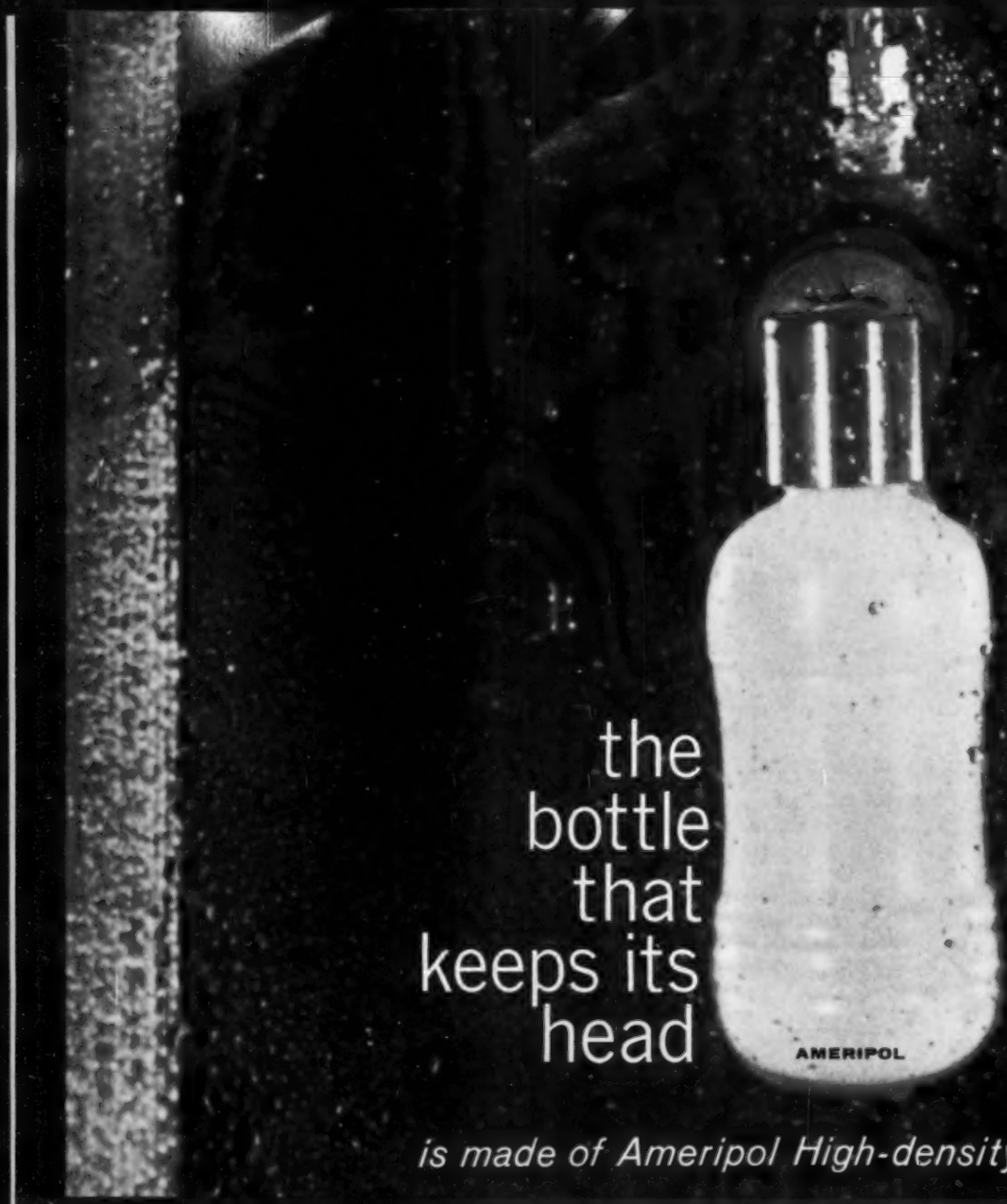

the bottle that keeps its head

is made of Ameripol High-density polyethylen

In the dramatic torture test shown here, identical containers were blow-molded from Ameripol high-density polyethylene . . . an from another high-density material. The Ameripol bottle and the control bottle were then subjected to an increasing head o hydraulic pressure. In hundreds of test runs, the Ameripol bottle outlasted its opponent every time. When the control bottl ruptured, the Ameripol bottle was still pressure-tight. Then hydraulic pressure was again applied to the Ameripol bottle unt it failed . . . at values ranging from 20% to 50% above the control bottle. This extra strength and durability of Ameripol hig density polyethylene can help you produce better quality containers and other blow-molded products at no extra cost. And Amer pol has one other outstanding advantage—it is easily processed on conventional equipment. For strong, beautiful blow-molde products check Ameripol. Write for Ameripol Technical Data file for complete physical properties and specifications. An remember—Goodrich-Gulf Technical Service can help you with application.

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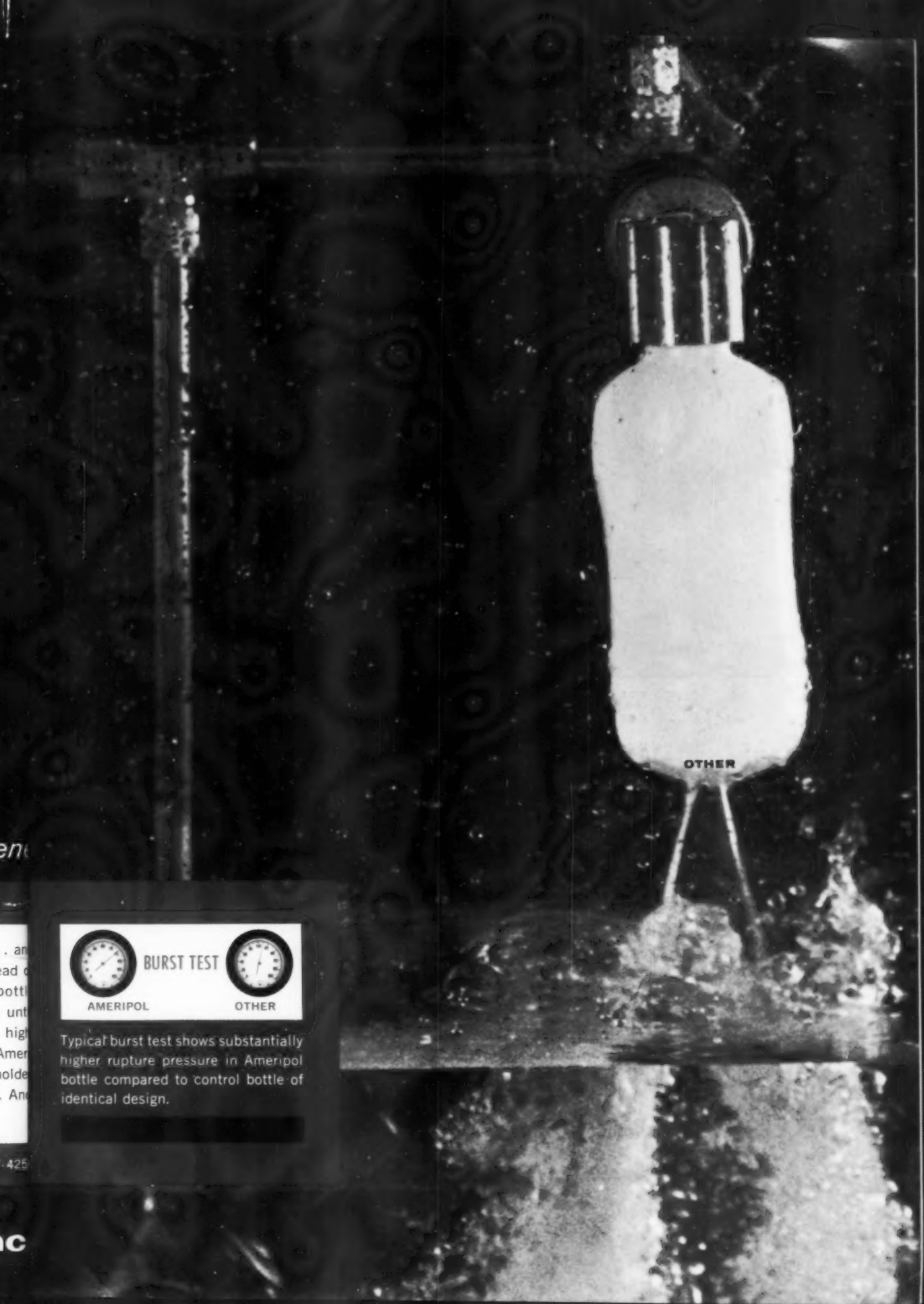
Goodrich-Gulf Chemicals, Inc

THE ONE TO WATCH FOR NEW DEVELOPMENTS



Typical burst test shows substantially higher rupture pressure in Ameripol bottle compared to control bottle of identical design.

Why the MOLDER

talks D-M-E SERVICE to the Mold Designer and Mold Maker

D-M-E Standard Mold Base Availability Cuts Production Costs!

Using D-M-E Standard Mold Bases and component parts, you can develop greater production flexibility . . . your way to greater production savings!

D-M-E Standard Mold Bases and components are carried in stock at your local D-M-E Branch ready for quick delivery . . . delivery when you need it! With D-M-E you eliminate waiting, cut downtime, reduce maintenance, reduce your inventory and maintain production schedules.

Whether for injection or compression molding, D-M-E Standard Mold Bases enable you to work with one single reliable source. This one-call, immediate delivery service can help you to cut production costs . . . and increase profits!

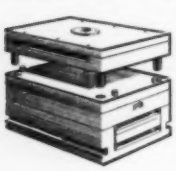
MOLD DESIGNER: D-M-E standard components are fully interchangeable: Replacements can be made without special fitting or reworking. D-M-E enables you to work with greater freedom by providing a selection of over 7,000 catalogued mold base combinations. And D-M-E Master Layouts enable designers to devote more time to cavity layout.

MOLD MAKER: D-M-E first-quality carbon or alloy steel assures easier and more reliable machining. And D-M-E Standard Mold Bases have exclusive built-in features at standard cost: surfaces ground flat and square; patented tubular dowels; one-piece ejector housing; stop pins welded to ejector plate; 33 sizes from 9⅞" x 8" to 23¾" x 35½".

FREE CATALOG

Write today for your 242-page D-M-E Catalog of Standard Mold Bases and Mold Makers' Supplies. No cost, no obligation.

61-B-P



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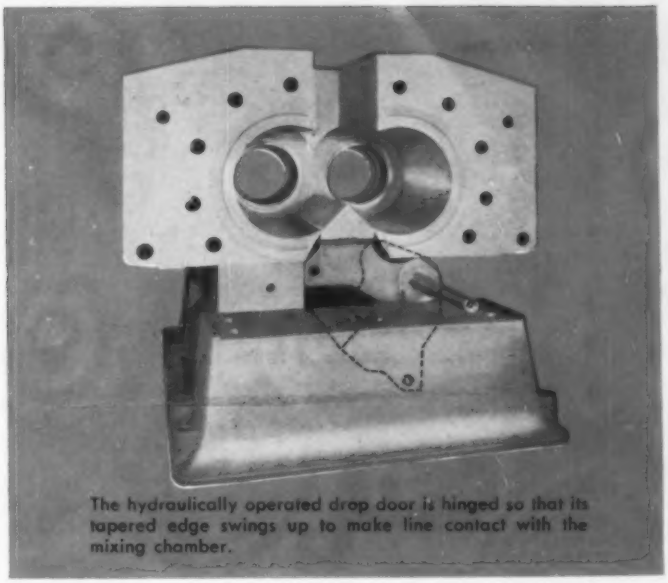


The hydraulically operated drop door is hinged so that its tapered edge swings up to make line contact with the mixing chamber.

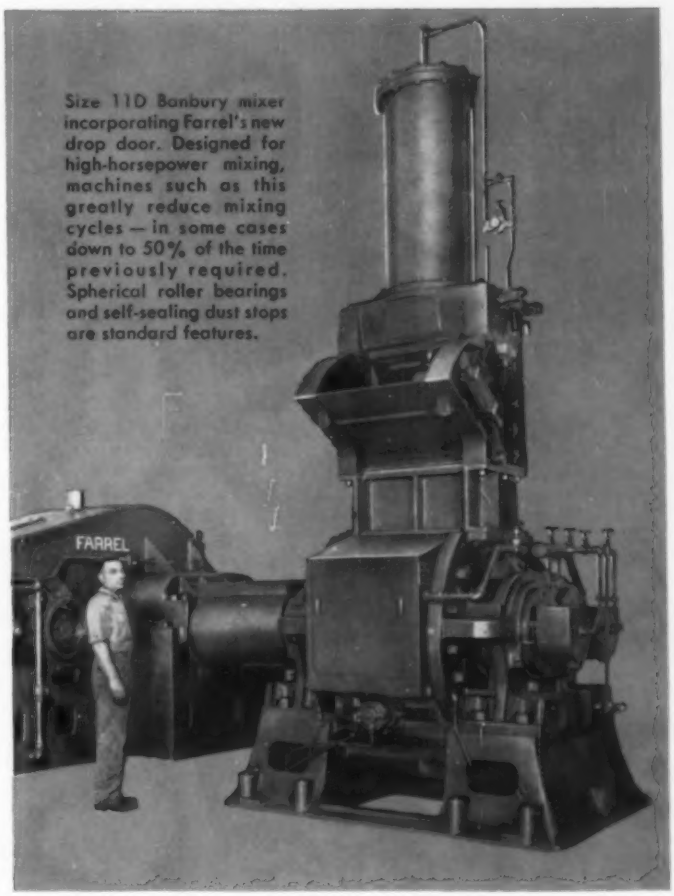
When you order a new body for your Banbury® mixer, you will find it profitable to convert to the new drop-door type. Reports from customers indicate a growing preference for this design based on its greater operational economy.

Experience has shown that the higher initial cost of a drop-door body is returned in six months to a year. This is accomplished by an appreciable reduction in cycle time due to the practically instantaneous action of the drop door and by the savings in material through the elimination of tail leakage and waste. Labor costs for cleanup are also reduced or eliminated entirely.

How a drop door for your Banbury pays for itself in less than a year

Drop-door bodies can be adapted to existing Banburys with little difficulty. They come with cored or spray sides to meet any processing need.

Bulletin 207 describes this development in detail. Send for a copy today.



Size 11D Banbury mixer incorporating Farrel's new drop door. Designed for high-horsepower mixing, machines such as this greatly reduce mixing cycles — in some cases down to 50% of the time previously required. Spherical roller bearings and self-sealing dust stops are standard features.

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FB-1219

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What's New in Processing

A butt-fusion technique for joining high density polyethylene pipe in the field has been developed by Phillips Chemical Co. Squared off pipe ends are placed in clamps so that they face each other. An aluminum plate, heated to about 400° F., is inserted between the ends for about 30 seconds, or until the pipe softens. After the heated plate is removed, the two molten pipe ends are gently pressed together, and after about 20 seconds cooling time the joint is completed and the joined pipe ready for the ditch.

U. S. Fiber Glass Industries, Inc., is currently producing a cylindrical liquid storage tank ten feet in diameter and 15 feet high. The manufacturing process, claimed to be unique, utilizes chopped glass fibers and polyester resin to form a one-piece cylinder. Separately molded ends are bonded to the cylinder with a polyester adhesive.

Abstracts

"Shaping the Product. 3—Design and Plastics Processing" by Thomas Gray, Plastics, March 1961, is the third in a series on plastics design. This article contributes information on structural strength of moldings, with reference to wall thickness and sharp corners; compression and transfer molding; blow molding, and sheet forming.

"Welding Polyethylene and Polyamide with Heating Tools" by G. Hartung, Plaste u. Kautschuk, July 1960, describes a series of tests to determine optimum welding strengths for these materials, and to establish short term tensile strength in relation to welding temperature.

"Foam Molding Goes Automatic" by Frank H. Lambert, Modern Plastics, February 1961, outlines the development and features of a process for automatic molding of expandable polystyrene beads.

"The Three-Dimensional Effect" by P. H. B. Moore, Applied Plastics, April 1961, describes one company's technique for second-surface metallizing and spraying. The article covers moldmaking, molding, spraying, and metal deposition.

"Colouring of Thermoplastics," British Plastics, April 1961, is a three-part feature dealing with problems and trends in introductory part 1, the dry coloring process in part 2, and extrusion coloring in part 3. The last two sections point out limitations and advantages of the respective methods, and equipment and conditions for optimum results.

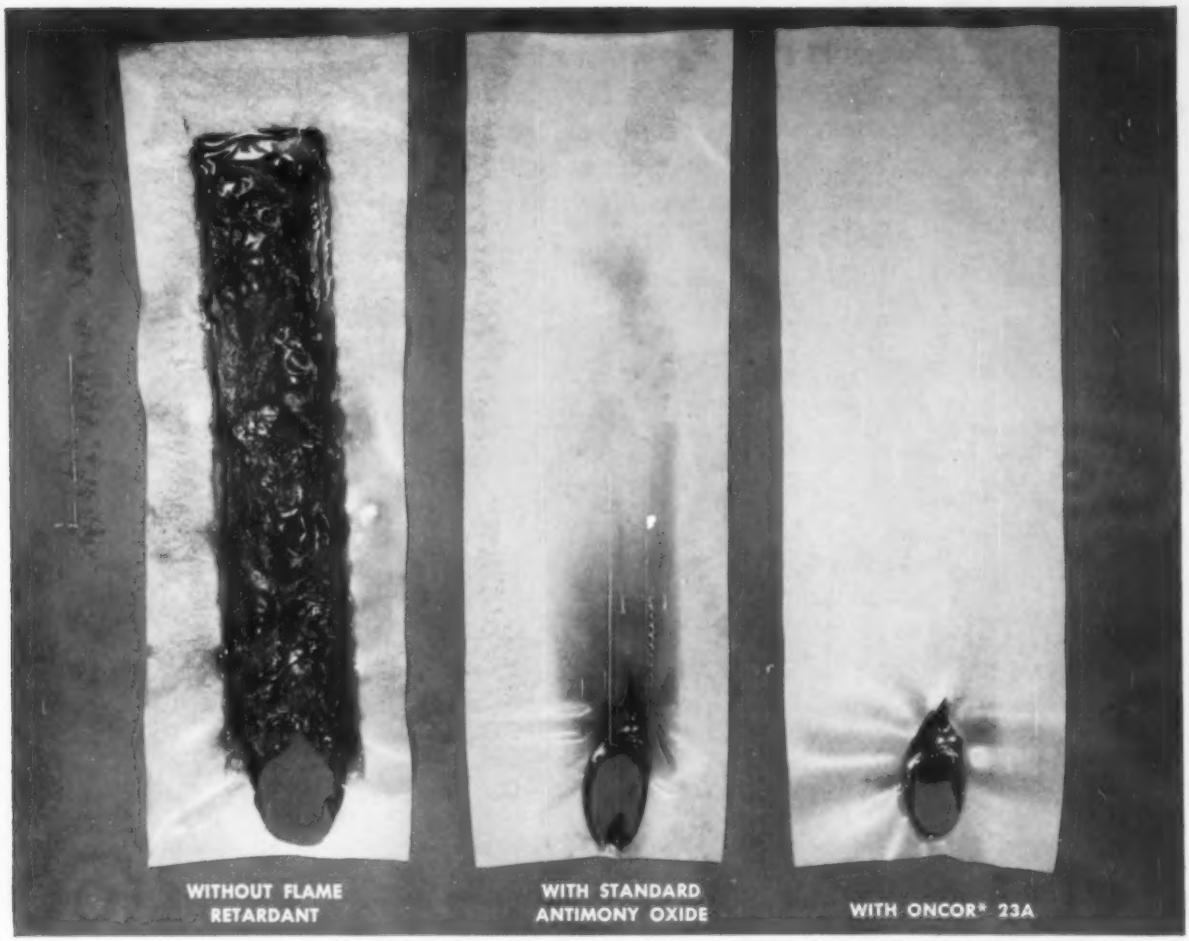
Patents

2,984,869 to Pritchett & Gold and E. P. S. Co., Ltd. In an improved method of producing micro-porous PVC sheet, the resin, plasticizer, filler, and solvent are mixed and spread on a conveyor belt. Solvent is evaporated, and the remaining cream passes through an oven which causes the resin and plasticizer to gel.

2,983,961 to Resistoflex Corp. A method of blow molding polytetrafluoroethylene.

2,983,962 to Monsanto Chemical Co. A continuous method for preparing laminated resin foam structures from thermoplastic sheet and foamable pellets.

2,983,963 to Aktiebolaget Elektrolux, Stockholm, Sweden. Method of forming an expanded plastic body, in which the core and shell are of different densities.



Typical results of recent flammability tests on 6 mil PVC film, following ASTM Method D 1433-56T. Antimony oxide and ONCOR 23A used at 5% level (resin basis)

Tests show effectiveness of

Oncor* 23A pigment...the cost-saving flame retardant for chlorinated-resin compounds

Effective, uniform flame retardance—the basic function of ONCOR* 23A—is combined with three important processing advantages that can add up to substantial economies in electrical insulation, paints, vinyl films or dipping plastisols.

Specific gravity is lower than that of conventional antimony oxides. ONCOR 23A has a *surface layer* of antimony oxide fused to an inert, lightweight silica core. The result is greater efficiency for every pound of antimony—at lower cost per pound. 23A is the most economical way to use an antimony oxide flameproofing agent.

Tinting strength is low and uniform — consistently 50% of a standard antimony oxide. Colorants can be used more effectively . . . smaller quantities are needed.

Dispersion is easy and uniform in plastics and paints. ONCOR 23A pigment particles are unusually uniform — the result of careful production controls.

Make your own evaluation tests. Find out the product and process advantages of ONCOR 23A pigment — in any halogenated plastic composition that needs flame resistance. It can be used with polyvinyl chloride, vinyl chloride copolymers, chlorinated paraffins, chlorinated rubber, chlorosulfonated polyethylene, chlorinated polyesters and commercial fluoropolymers.

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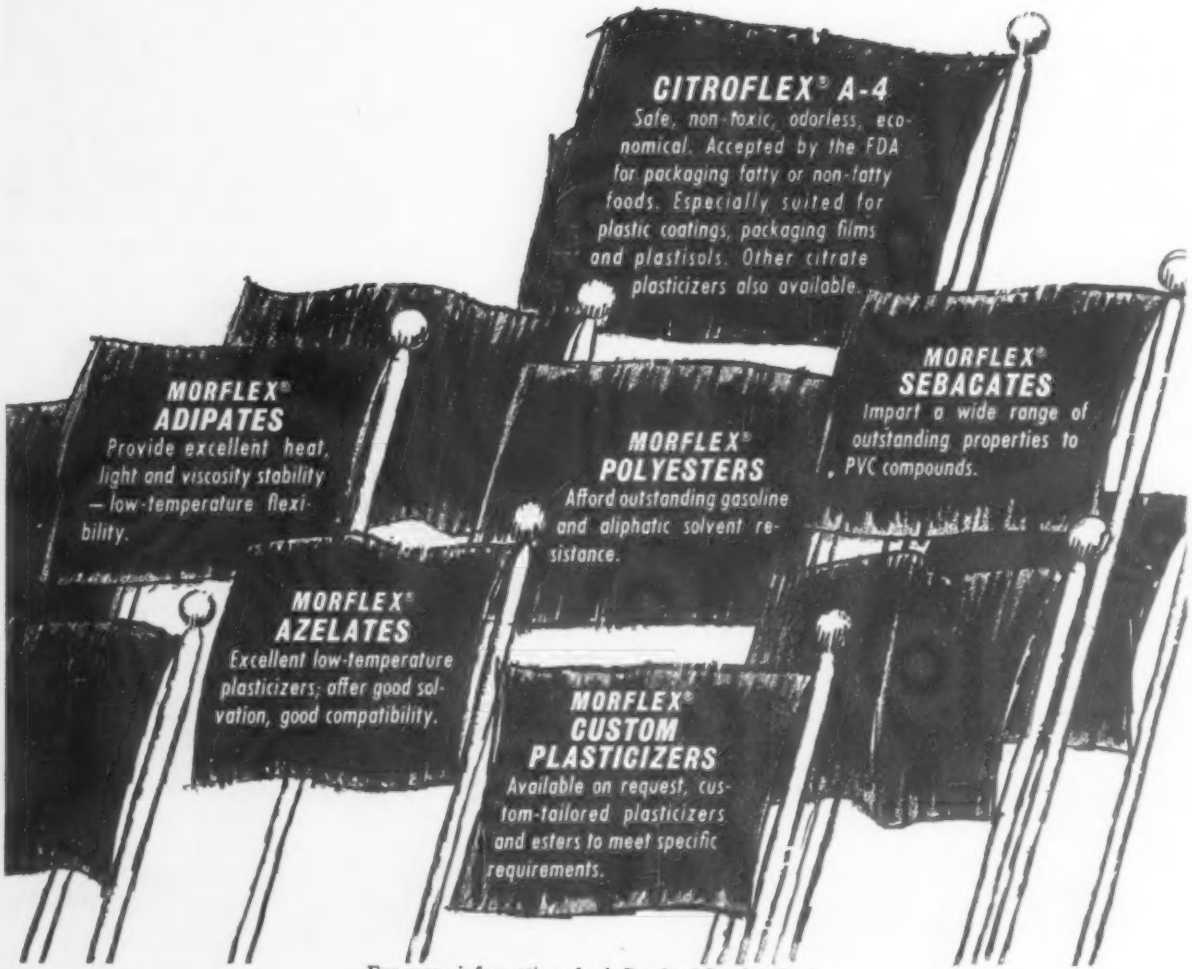
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editorial: PLASTICS—AN ALTRUISTIC BUSINESS

Webster defines altruism as a regard for and devotion to the interests of others. A beautiful ideal, but it hardly belongs in a competitive business—or does it? Certainly not, if carried to an extreme, but neither does its antonym—complete selfishness. Business dealings, like human behavior, are seldom black or white but the "white knight" of plastics has gotten a little too grey. And what's the result? The profit has gone out of plastics molding!

In a competitive economy, no one expects altruism. But if you try to cut someone's throat, you may end up cutting your own. Like practically every business, plastics is composed of suppliers, processors, and end-use manufacturers. Our prime concern at PLASTICS TECHNOLOGY is the processor, the middle man—and lately, he's no lucky Pierre!

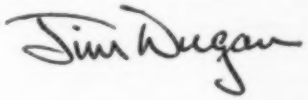
We, in America, should like competition. It has been the basis for our success to date. But this past success and competitive edge was built on hard work, initiative, and quality—not cutthroating and piracy. For a long time, plastics has been referred to as the "wunderkind" of industry, but it's about time the child grew up! And it's about time some of the industry leaders exercised a little adult thinking, or the plastics industry may become a juvenile delinquent.

Strong words? I don't think so. What has happened to the vinyl industry is a disgrace, and the same thing threatens in polyolefins. An honest evaluation of the basic costs, research & development, advertising & promotion, and a fair return on investment just couldn't give the ridiculously low figure some materials are being sold for today—certainly not and meet today's wage demands.

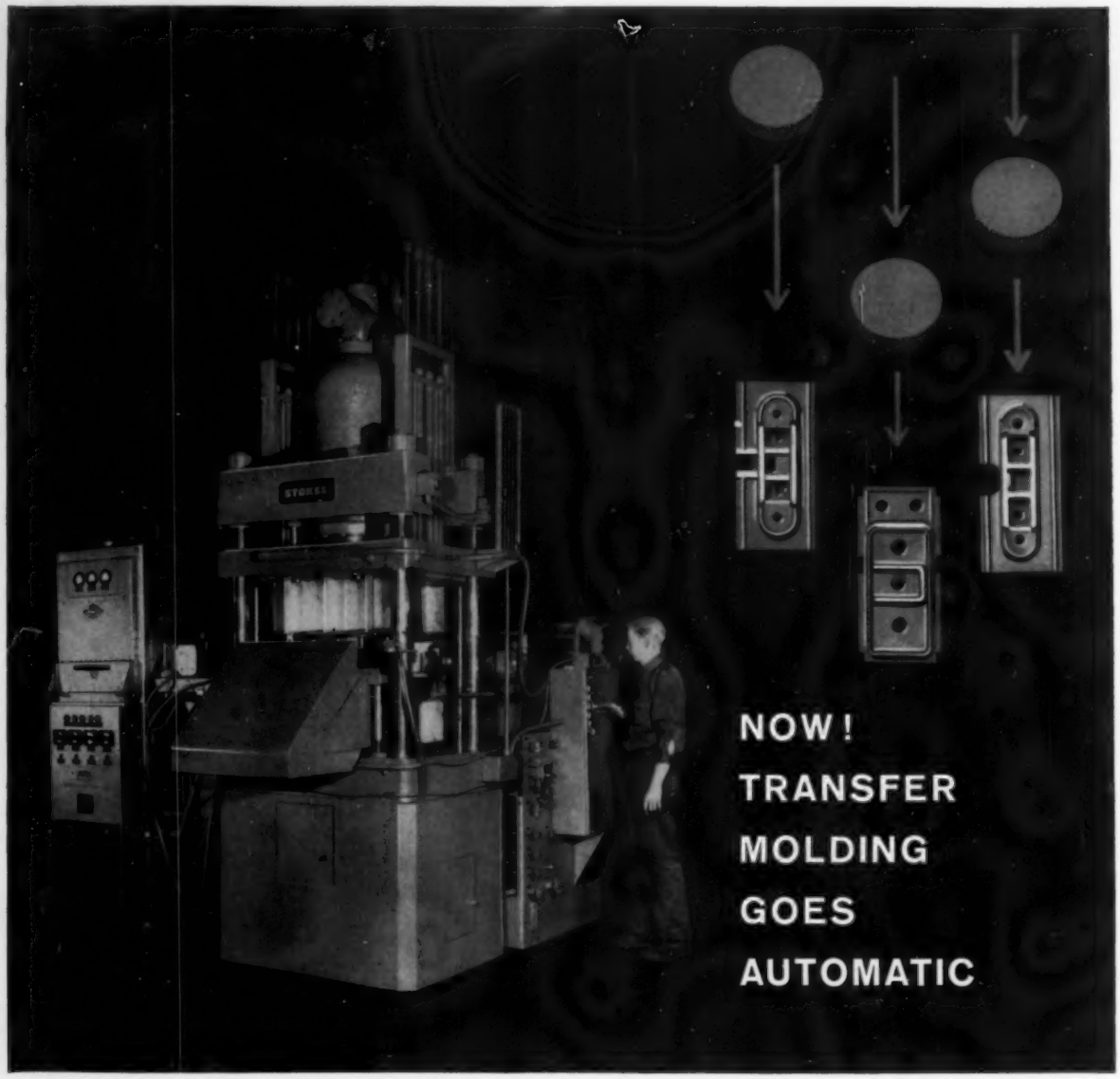
Does the processor profit by these lower material costs? He does not. When prices have no stability he doesn't dare buy in bulk nor can he give a realistic quote to his customer. To be specific, next month we are running an article by Dale Amos of Amos Molded Plastics—based on a talk he gave before SPI's Custom Molders Division Workshop. Asked what was the future of custom molding, he said "I don't agree 100% that we have a future." He did, however, feel that now was a good time to take stock and see what the future will be. He also stated that it would be a good idea for custom molders to consider going proprietary—keeping a cautious eye on captive operations.

When material prices are unstable and low, the only one who can profit (if he keeps his head) is the one offering a consumer product. If he passes it on, we get a situation such as we saw in 1950-51 when quality products such as Bayer aspirin sold for 7¢/100. And did the housewife appreciate the saving? She did not! She suspected the quality.

Getting back to the original question —is plastics an altruistic business? The answer is a definite no! However, a little regard for others is definitely in order. Without it you literally can't give things away, let alone sell—and sell at a profit.



Editor



This 200-ton transfer molding press—the largest of its design ever built—*feeds, preheats, loads, molds, ejects, and sorts automatically!* Operator has only to load the preforms into the hopper and remove the finished parts in bulk. The Stokes Model 741 does the rest!

New flexible, fully-automatic feeding system gives fast, continuous operation. This integral system delivers the prescribed number and size of preforms to the electronic preheater and, from there, carries them to the transfer pot. Controlled feeding of stacked preforms to the mold reduces air entrapment and provides fast, uniform loading. Shorter transfer strokes result in faster cycles.

Independent speed and pressure control of clamp and transfer system permits maximum flexibility in the molding operation. Short shot, over-charging, and mold flashing are detected automatically. New combing and ejection system automatically separates the cull and runners from the finished molded pieces.

Get more complete technical information on Stokes complete line of automatic transfer molding presses by writing for literature. Be sure to ask for a Stokes production analysis on your particular application requirements.

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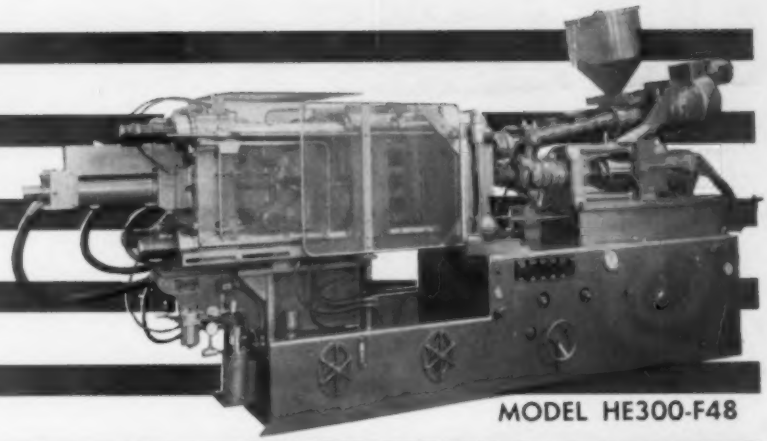
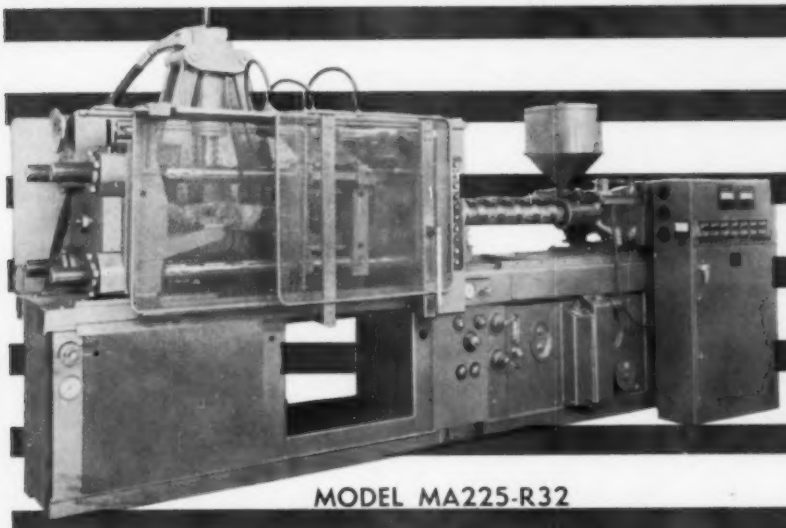


MODEL HE300-F48



MODEL MA225-R32

ON IMPCO INJECTION MOLDING MACHINES

To meet the needs of the plastic molding industry, Impco offers a complete line of screw plastifiers. Various design adaptions for this type of plastifying are now available on all of our machine models. Bulletins describing these adaptions as applied to Impco 175, 225, 275, 300 and 450 ton clamp models are on hand. Send for them today. We will be happy to discuss these and other significant improvements with you.

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In these flame tests, one epoxy strip ignites and burns rapidly; the other, containing Aroclor, won't ignite at all.

AROCLORS are COMPATIBLE with virtually all plastics resins • polyvinylidene chloride • cellulose acetate-propionate • polyvinyl acetate • chlorinated rubber • ethyl cellulose • benzyl cellulose • polystyrene • nitrile rubber • phenolics • polyamides • epoxies • acrylics • urethanes • polyesters • polyethylene • nitrocellulose • polyisobutylene • styrene-butadiene • polyvinyl butyral • polyvinyl chloride • cellulose acetate-butyrate

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HOW TO "BUILD IN" HIGH RESISTANCE TO FIRE AND CHEMICALS WITH LOW-COST AROCLOR® PLASTICIZERS AND RESIN EXTENDERS

AROCLOR *chlorinated* polyphenyls—liquid or solid—offer remarkable *inertness*. They don't burn, evaporate, hydrolyze, or oxidize. They defy strong acids and alkalies. They blend readily with nearly all resins, solvents, plasticizers, and other plastics-compounding ingredients. You can choose from 13 standard AROCLORS—to impart outstanding flame retardance, chemical resistance, and other desired properties to your plastics compounds and protective coatings . . . *at low cost.*

NONBURNING EPOXIES

Aroclors are fully compatible with epoxy resins. Combined with a small amount of antimony oxide, they produce *nonburning* compositions. Aroclor 5460 yields epoxies with optimum compressive strength. Aroclor 1221 greatly improves flexibility.

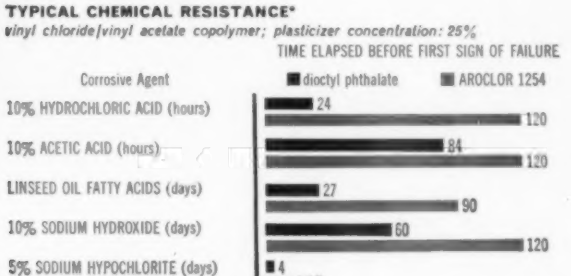
	AMINE-CURED EPOXIES		PHTHALIC ANHYDRIDE-CURED EPOXIES	
formulation	**control**	**modified**	**control**	**modified**
liquid epoxy resin	100	100	100	100
diethylenetriamine	13	13	...	...
phthalic anhydride	...	...	75	75
antimony oxide	...	5	...	5
DMP 30 (Rohm & Haas)	...	...	0.1	0.1
AROCLOR 1260	...	15	...	...
AROCLOR 5460	...	...	...	15
properties				
compressive strength, *psi*	43,000	38,150	23,400	40,700
flexural strength, *psi*	20,100	22,100	16,900	19,000
heat distortion, °C.	117.5	92	143	135
FLAMMABILITY—*inches per minute* (ASTM D635-56T)	0.82	NON-BURNING	0.6	NON-BURNING

EXTENDERS FOR PVC

Aroclors are especially effective as secondary plasticizers or extenders for polyvinyl chloride. Aroclor 1262, used 1:3 with dioctyl phthalate, sharply reduces migration to nitrocellulose lacquers. All Aroclor compounds can be used to improve the chemical resistance of vinyl chloride–vinyl acetate coating formulations.

TYPICAL CHEMICAL RESISTANCE*

vinyl chloride/vinyl acetate copolymer; plasticizer concentration: 25%



Plotted from independent evaluation data by the Northwestern Paint and Varnish Production Club** (The Official Digest, Nov. 1955). Conclusion: **"The Aroclor 1254 had the best all-around chemical resistance."

SELF-EXTINGUISHING POLYESTERS

The highly chlorinated Aroclors (1260, 5460, 4465) effectively and economically retard flame in polyester resins and do not significantly affect resin properties. Aroclors improve impact strength, too, and also increase the flexibility of the naturally brittle resin at less cost than plasticizing polyesters.

	POLYESTERS	
formulation	**control**	**modified**
polyester	100	100
styrene	56.5	56.5
antimony oxide	—	15
AROCLOR 5460	—	15
methyl ethyl ketone peroxide (60% in dibutyl phthalate)	3.2	3.2
cobalt naphenate (1% solution)	1.6	1.6
flammability	flammable	SELF-EXTINGUISHING

NEW BOOKLET **gives the facts about "Aroclor Plasticizers"... compounding procedures, performance data, property tables, specific formulas. It tells how versatile AROCLORS could be your answer for better compounds at lower cost. Mail the coupon today**

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Monsanto, maker of more plasticizers than any other company, provides these benefits to customers:

precisely right plasticizer systems

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( ) CS-14, "AROCLOR PLASTICIZERS IN EPOXY RESINS"

I'm interested in Aroclors for.....resins.

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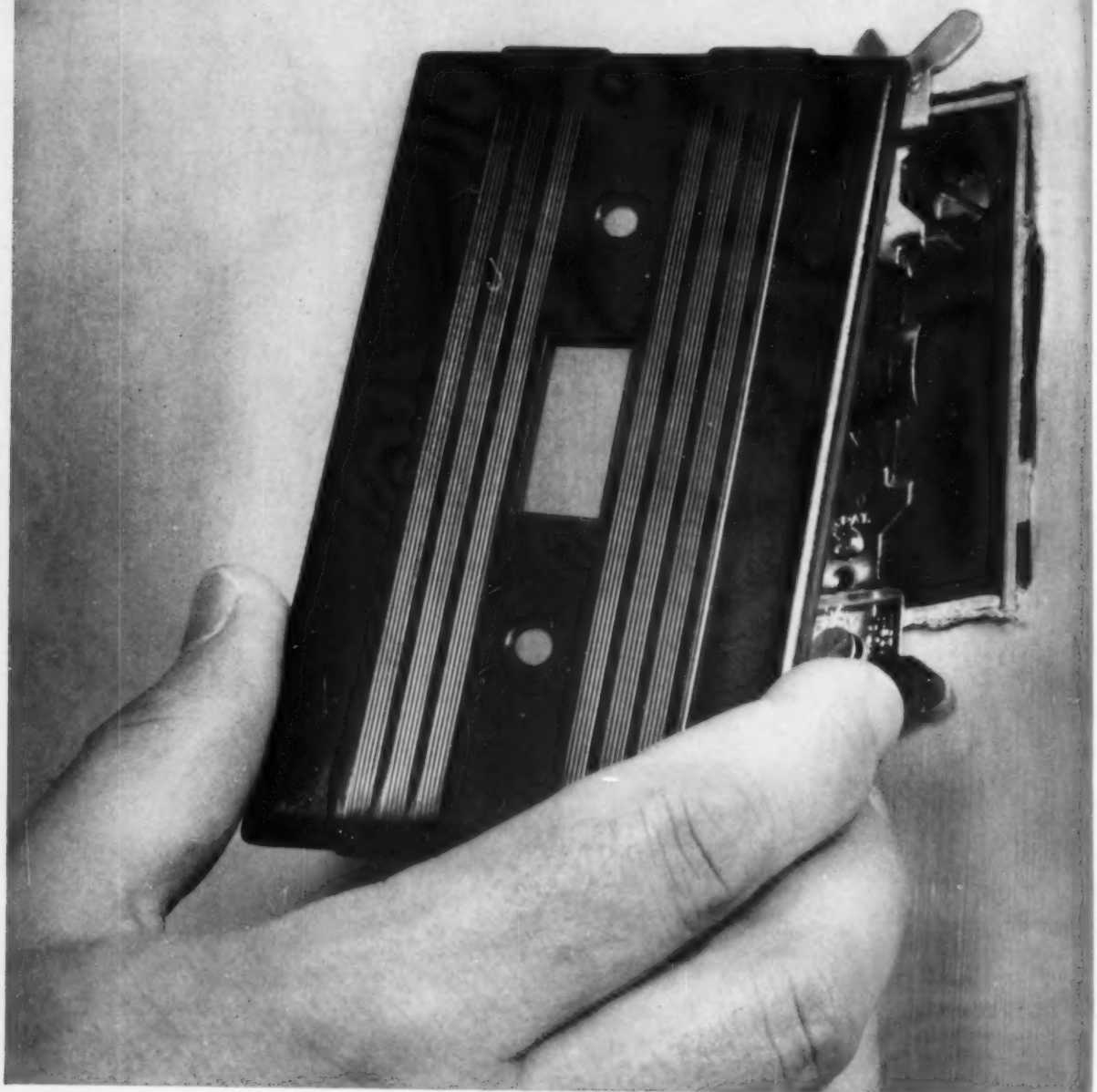
TODAY: THIS PART WAS MOLDED IN 30 SECONDS!



IN 1951: It took a minute and a quarter!
IN 1931: Over two minutes!

New BAKELITE BMM-7017 is one of the fastest-curing phenolics available. Nothing old about this workhorse—it dramatically highlights an overall 300% improvement in cure speed since 1931!

To stay new in phenolics takes research and development—in real depth. To give the manufacturer continuing improvements in moldability *and* product takes a complex team of men and equipment. You'll find them at UNION CARBIDE. For example, here are 4 new BAKELITE compounds you'll want to know more about:

BMM-7017, a general purpose two-step compound, is setting new production records in the field. Excellent mold and flash release. In cold powder automatic molding, 15% to 40% cycle reductions in fast-acting presses. Supplied in a new dust-free 16 mesh granulation.

BMG-2700 is becoming the new standard of the closure industry. A one-step compound, it is bleed-resistant, gives minimum odor. Offers not only very fast cure, but high torque strength, excellent moldability. Ideal for automatics.

BMG-2933, originally developed for vaporizers, gives excellent resistance to boiling water and low-pressure steam. High impact strength and fast cure as well. A one-step compound, it imparts no odor or taste to boiling water, keeps its good appearance after steam sterilizing.

BMGA-4127 and **BMGC-4011** still in the development stage, promise completely new thresholds of heat- and arc-resistance for phenolics. Laboratory tests reveal 4 times longer strength retention at 500°F. Can be used at temperatures 75° higher. ASTM arc-resistance values: 195 seconds average . . . 180 seconds minimum.

Want more information about new developments in BAKELITE phenolics? Just write Union Carbide Plastics Company, Dept.JZ-105H Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

UNION CARBIDE **PLASTICS**

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FIFTY YEARS EXPERIENCE IN PHENOLICS

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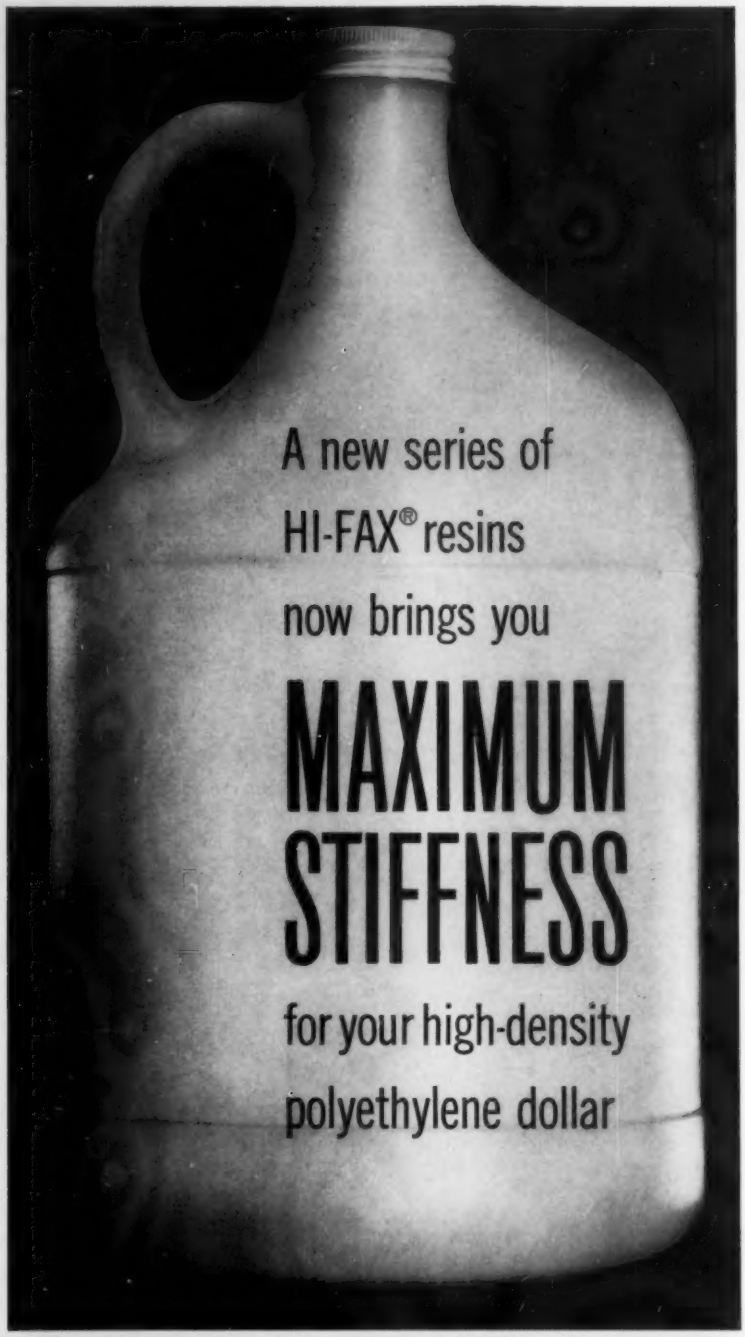

NEW 0.962 HI-FAX RESINS

Series	Melt Index
Hi-fax 2600 E	0.2
Hi-fax 2400 E	0.9
Hi-fax 2300 E	1.5

Another first for Hi-fax: 0.962-density resins in three different melt indexes. Produced by the exclusive Hercules process with Ziegler catalysts, this new economy form of Hi-fax is the first material of its type commercially available in America. Check these outstanding features of this important addition to the Hi-fax family:

Maximum stiffness
Superior surface gloss
Sharper light transmission
Increased resistance to permeation
Low cost

Add to all this the established processing advantages exclusive with Hi-fax, and the door is opened to a whole new vista of profitable markets.

Liquid bleach packaging appears to be one of the largest potential markets for these new Hi-fax resins. With its high degree of stiffness and excellent resistance to permeation, 0.962-density Hi-fax is one of the few materials capable of handling this hard-to-package product. In toys, sporting goods, durable housewares, and containers for motor oil, waxes, and a variety of household and industrial chemicals, blow molders are already making use of its improved surface finish, translucency, and merchandising appeal.

The scope of this versatile new resin reaches beyond blow-molding markets to such fields as extruded monofilaments, rigid sheets for vacuum-forming, and injection molding . . . wherever its outstanding stiffness, impermeability, and attractive surface finish provide the product advantages you require.

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PLASTICS
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TECHNOLOGY

Should I buy a movable screw injector?

A. R. MORSE*

Shortcomings and limitations of the movable screw injection machine are pointed up, with emphasis on injection pressures. These are considered by the author (and others) to be inadequate for rapid and complete mold filling, with slow and costly cycles being the result. He feels that, at present, the screw unit is pretty much limited to very large parts and to the more difficult materials such as vinyl, nylon, acetals, and the polycarbonates. He does point out though, that inadequately cooled molds have slowed European cycles—possibly more so than do the filling rates. I have heard, for example, that a 200-ton screw press was able to fill a 86-cavity 3M mold for vinyl insulating caps. There remains much to be said on the subject, which is a really hot one.—Editor.

Injection molders at the recent SPI Show in New York City (June 6-10, 1961) had one paramount question in mind: "how does the movable-screw injection molding machine fit into my future?" Rather than resolving this question, the Exhibits seemed to confuse the situation further. Some conclusions on the subject of movable screws could, therefore, be made to help the molder decide whether to jump onto the movable screw band-wagon or to wait awhile.

First and foremost it was obvious that American manufacturers were not actually ready to show their movable screw injectors. One manufacturer was even forced to withdraw from the show because the barrel of his machine split and he could not replace it in time for the show deadline. Given another 9 months to a year, American press makers could have made a much more effective display.

Injection pressure—key factor

Among the many unanswered questions is: "how do screw-injected parts stand up under crazing and aging tests when the plastic is not fully packed into the mold under optimum pressure (generally considered to be 20,000 psi., regardless of the type of machine used)?" There is already ample evidence that parts molded at low injection pressures of 15,000 psi. and under are not fully formed even though they may be visually satisfactory just after molding. Perhaps the most damaging bits of evidence against the movable screw seen at the Show were warped parts and streaks which indicated strains and uneven plasticizing were still present.

The second question, therefore, involves the injection pressures necessary for good quality molding with a movable screw device. That these pressures are presently inadequate was clearly demonstrated by the number of two-stage injectors seen at the show. These are not true movable screw units, but a hybrid species of preplasticizer. Here, the shooting cylinder is mounted ahead of the plasticizing unit, usually above it and at right angles to the melter. The fact that several important press makers elected to use secondary injectors to supply the kind of injection speeds and pressures which many movable screw machines do not seem able to generate seems highly significant.

Most shots seen to date on movable screw injectors are of the single cavity or bottom gated type. Here, a small machine is used to mold a small part, and a larger press a bigger one. This would indicate that a much larger movable-screw press is needed to mold a part than if the older plunger type were used.

Other factors

Questions as to how well movable screw injectors work on family or multi-cavity molds are, therefore, still largely unanswered. How would they handle a 60-120 cavity, high speed novelty mold? How would they do on a 12-16 cavity wall tile or comb mold, or on a 150-cavity button mold? All of these are now run as fast as possible on plunger-type machines, usually on 14-17 second cycles, and consume 60-120 pounds per hour.

A third area of comparison involves color change.

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Some demonstrations were made which, on the surface, were quite spectacular. They did not seem too convincing, however, since results were not compared to a standard color. In our own color-change work with screws or movable spreaders, we have learned not to confuse apparent changes in color with an actual clean-up. Weeping material from the screw tip is often so well blended-in by rotary motion that one is often misled into thinking that a color change is complete, when actually it is not.

A fourth major question—why were there so many different basic press designs, featuring both pre-plasticizing devices and movable screws of various principles? Many molders felt that the ultimate design of a single screw injection unit had not yet emerged.

Plasticizing rates of movable screws were not being boasted about. In fact, the whole area of relative plasticizing efficiency was definitely soft-pedalled. No one seem to know how many pounds per hour a movable screw press will plasticize *and mold* compared to an equivalent plunger type machine. Similarly, no one heard how much less (or more) it cost to plasticize a pound of plastic with a movable screw as compared with a heating cylinder.

Cycles and costs

One reason there was so little bragging about speed records and cost cutting with movable screws is that virtually all testing was done under what one might call "European molding contions." Here, much slower cycles are run at sharply lower foreign labor rates on much less efficiently cooled molds. Plasticizing rates and costs abroad simply are not the pressing problems they are in this country.

At the previous SPI Exhibit in Chicago more than two years ago, at least 2 leading American injection machines of the plunger type were shooting thin-section boxes weighing 3-5 ounces at cycles as low as 3 seconds. At the recent show, the most a movable screw seemed able to do was a 1-oz. shot on a 4-5 sec. cycle. This year, by far the biggest shots and fastest cycles were being demonstrated on plunger type machines. There, family molds were far out-producing anything seen on the movable screw presses, and at lower cost.

Here is a fact to be faced: the movable screw is NOT an advance in the sense the cost-conscious American molder expected it to be. It does not give positive assurance of bigger shots, faster cycles, and lower costs. If anything, the movable screw actually represents a trend in the opposite direction toward slower cycles, lower output per operator, and higher and more specialized maintenance costs.

Especially important is the lack of flexibility due to lower injection pressures and strict limitations on shot sizes. This is due to the limited displacement area ahead of the screws which prevents stuffing or double shooting, and the widespread use of over-size shots which the American molder must have in order to meet competition. Granted that extra shot size can be taken care of by going to a larger diameter screw or a longer stroke, what about the lower plasticizing rates and pressure drops? At the Show, we heard nothing about oversize barrels and extra wattage for greater output and faster cycles. In fact, reduced wattages and power requirements were featured in some cases.

Many molders were highly skeptical about the ability of a skinny, low-wattage barrel being able to put out from 60 to 200 pounds per hour just because it had a screw turning inside it. Supposedly the friction of the screw generates enough adibiatic heat to make up the 10,000-30,000 watt loss between the movable screw machine and its plunger type equivalent. Extruder manufacturers, too, seemed doubtful as to the efficiency of the movable screw devices, mainly because screw action was not continuous.

One molder summed it up this way: "It looks like we are going to be guinea pigs again while the press makers work the bugs out of their movable screws!" Another likened the situation to the family man who bought a Mack Truck. "It was transportation," he said, "but it was not necessarily the right vehicle for the job. It gets you there, but the ordinary man could not afford the cost of running it." To the cost and speed-minded American molder, the movable screw begins to seem more and more like an expensive novelty than a cure-all.

The most interesting technical questions were those pertaining to the shooting barrel. Today, nearly all extrusion barrels are made by casting a corrosion resistant liner inside a steel tube or outer body. Such barrels are thoroughly proven in extruders, but whether these same barrels will be able to stand injection pressures which far exceed those of extrusion, plus the additional wear of lateral screw movement without excessive galding or cracking remains to be seen. Corrosion resistance is a big feature of extruder barrels, but is of little importance in injection molding. Why buy a costly, chemically resistant barrel to mold polyethylene and polystyrene? Should special alloy liners be used in the nose and nozzle of the screw injectors, and what about tramp metal?

Capacities

By far, the most popular injection machine today is the 16-12 oz. The big question, then, for expansion-minded molders is at what point does a pre-plasticizer or a movable screw actually begin to out-produce a conventional plunger press? The consensus of opinion seems to be that for shots of 48 ounces and under (on most molding materials), the plunger type press is just as good if not better than a screw injector. For larger parts it becomes too costly to build and power single-stage heating cylinders which will plastify with the speed and ease of a screw.

Cost alone determines the size and efficiency of the screw selected to fill the shot cylinder. Many of the extruder's expensive features can, of course, be eliminated in a simplified pre-plasticizer. It is obvious that many large injection molders have just been fooling themselves when they call a press a 200- or a 300-ounce machine. Actually, it is nothing more than a standard 48- or 60-ounce heating cylinder mounted to fill an over-size shot chamber. Terminology for large presses is especially confusing because it refers only to the

displacement of the shot chamber and not to the size and efficiency of the plasticizing unit.

Plunger melters have, in fact, been limited to the 48-60 ounce heating cylinders through which plastic is pumped willy-nilly until enough material is stored in the shot chamber to make a 200- or 300-ounce shot. For thorough plasticizing on presses of 100 ounces and over, a simple screw type pre-plasticizer is definitely indicated. Such a development will improve large press performance (relatively speaking) far more than any immediate application of single or movable screws on smaller machines. The larger number of big machines being converted from pre-plasticizers back to single-stage conventional plunger type certainly proves that the pre-plasticizing unit did not have enough capacity to convert the press into anything much bigger than 60 ounces.

The bona fide injection molders among the hordes of sample grabbers crowding the machines on exhibit wanted definite answers to the problems encountered with movable screw machines. There is still an almost complete lack of descriptive literature and comparative performance specifications for these units. It is almost impossible to determine performance without extensive in-plant evaluations. Just what are the limiting factors in modern injection molding, and how are these variables affected by the slower injection speeds, the lower injection pressures, and reduced plasticizing capacity of equivalent movable screw injectors?

It is surprising how often molders and machinery builders have overlooked the most important factor now determining injection speeds—how fast can the mold cool the injected part? The cost and amount of speed built into injection machines during the last two years (for which the average molder cannot find an economical use) are obvious areas for the proponents of the movable screw to investigate.

Injection variables

Other important factors are how much shrinkage, warpage, and strain can the molded part stand? At what point does a decrease in injection pressure cause the plastic to fail to consolidate into a homogeneous mass? Other variables affecting injection molding efficiency pertain to the wide variety in molding materials now being offered and the variety of formulations. Now that one plastic is replacing another, and with the gassing and decomposition characteristics of the newer, heat-resistant formulas, there is a definite place for a movable screw type machine.

With one or two exceptions, the pumps and motors of movable screw injectors are a fraction of the size used in the equivalent plunger type machine. The results, of course, are slower, lower pressure injection in line with the smaller plunger displacement and a claimed elimination of pressure loss because the screw is pushing directly on molten material. This old fallacy is based on the assumption that the high injection pressures used are needed primarily to overcome pressure absorption by the cushion of granular material ahead of the plunger, and not to fill the mold. There is increasing evidence from experience with pre-plasticizers and existing screw type machines that pressure losses on plunger type machines are actually rather small, and that available injection pressure of at least 20,000 psi. is needed to make a good molding no matter what method of plasticizing is used.

In addition to internal pressure losses on the movable screw, cycle time is likely to be stretched out either by the needs of the nozzle shut-off mechanism, or the necessity of leaving the mold closed while the screw is turning to fill the shot reservoir. Shut-off valves, sliding valves, small spreaders, and other devices ahead of the screw are added complications necessitated by the movable screw principle. Often, they tend to undo the good mixing action of the screw by marking the plastics, filling it with strains, and causing hold-ups, streaks, and burns.

Our own thinking about in-line screw type attachments for older machines helps accentuate the specialized nature of the movable screw. On the Reed 10D8, for example, we simply remove the heating cylinder and bolt onto the old housing our own design of movable, vented, hollow screw-type plasticizer. The existing plunger supplies the necessary injection pressure. We can achieve a spectacular 18.95-ounce displacement with a 2½-inch screw at 22,000 psi. effective injection pressure.

On the 2½-oz. Van Dorn, our in-line attachment has a shot size of 4-6 ounces. The attachment can be removed from the Reed type machine in 3-4 hours, and the conventional plunger replaced. On the Van Dorn, reconversion takes only a couple of hours. But where high speed, high production, and lowest net cost are wanted, we still recommend that the molder utilize an Extra Capacity plunger-type heating cylinder. Even though these in-line screw type attachments have some spectular features, we still recommend them mainly for vinyl, rigid PVC, the acetals, polycarbonates, and for jobs where cycle and part cost are clearly secondary.

Summary

The way things stand in the injection molding industry here in the summer of 1961, most molders seem to feel that movable screw injection machines cannot be regarded as cost cutters or production boosters. It seems likely that screw injectors will supplement rather than replace the plunger type press. Profitable applications for movable screws will hinge on lower prices and greater use of the acetals, the polycarbonates, vinyls, and rigid PVC. Installations made for use on these materials will pay off, while installations designed solely to replace older style plunger type machines may lose money.

Molders who have been fearful of sudden loss in dollar value for their old plunger type machines can definitely take heart, if reports from molders visiting the SPI Show are to be trusted. While only partial information is available, it seems an educated guess that more plunger type machines were sold at the Exhibition than any other. Molder after molder apparently made up his mind to wait for applications to develop where the movable screw could be utilized economically.

—The End

Dr. W. Fisch

Dr. W. Hofmann

Reaction mechanisms, chemical structures, and changes in properties during the curing of epoxy resins.

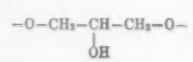
DR. W. FISCH* AND DR. W. HOFMANN*

New analytical methods disclose certain correlations between the chemical composition of a cured epoxy resin and its physical properties. Control of the exothermic reaction during cure of large castings results in low shrinkages. The dependence of chemical structure of the cured structure on the curing temperature is demonstrated.—Editor.

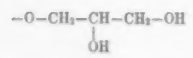
Some results of research on the chemical processes which take place during the curing of epoxy resins with phthalic anhydride (PA) were reported by our laboratories a few years ago.[1,2]# By using incurable systems, analogous to commercially available resins as far as concentration and structure of the reactive groups are concerned, and partly through the use of commercial resins themselves, we were able to go a long way towards explaining the reaction mechanism.

The reactive groups present in commercial epoxy resins, obtained by reacting epichlorohydrin with bisphenols, are terminal epoxy and hydroxyl groups. The latter are generally classified as follows:

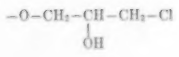
(a) Glycerol diether groups



(b) Glycerol monoether groups derived from the hydration of glycidyl ether groups

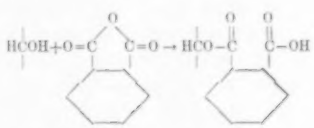


(c) Glycerol chlorohydrin ether groups which have remained in small quantities unreacted during dehydrohalogenation



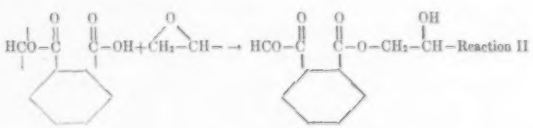
It has been proved that in the presence of dicarboxylic anhydrides, the following three reactions take place:

The anhydride reacts with one of the above mentioned hydroxyl groups of the epoxy resin to form a monoester.



Reaction I

The free carboxylic group of the monoester reacts with an epoxy group to form an ester and a new hydroxyl group.



Reaction II

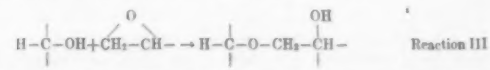
Since the epoxy and hydroxyl groups present in the epoxy resin react with each other to any measurable extent above approximately 200° C., the reaction possibilities are exhausted with Reactions I and II at the usual curing temperatures. The analytical values estab-

* CIBA Limited, Basle, Switzerland. Inquiries on this paper may be addressed to CIBA Products Corp., Fairlawn, N.J. Based on talk given before ACS in Atlantic City, N.J.

Numbers in parentheses refer to bibliography at end of article.

lished throughout the curing process, however, leave no doubt as to the fact that the epoxy group continues to react to a marked extent along other lines. It has been possible to prove conclusively that this reaction is the following:

An epoxy group reacts with an hydroxyl group to form an ether and a new hydroxyl group.



Reaction III

This reaction, described above in connection with Reaction II as negligible, becomes important in the curing system under the catalytic influence of the acid or anhydride groups. (It should be recalled that the analytical values do not distinguish between Reaction III or polymerization of the epoxy group since the hydroxyl content remains constant.)

Fundamental Conclusions, Reactions I—III.

Reaction I

Reaction I, a reversible reaction, is a monovalent addition of a low molecular weight anhydride to an epoxy resin molecule and, therefore, does not participate in the cross-linking to the macromolecule. Starting with a pure monoester or with monoester-containing mixtures, we have been able to prove conclusively[2] that the values given previously for the equilibrium and its temperature dependence for Reaction 1, are correct. An equilibrium reaction entails the following consequences:

(a) All three reactive groups (anhydride, hydroxyl, and monoester) are present in the final product. Their concentrations are dependent on the curing temperature or on the post curing temperature.

(b) Volatile compounds, which are part of the equilibrium, will displace the reaction to one side if they escape from the system. In the case of epoxy resins cured with PA, therefore, it is possible, through application of heat after the cure to evaporate from the surface not only the free anhydride but also, by reversing the equilibrium reaction, practically the whole monoester content in the form of anhydride.[2]

This surface effect is still more marked during the curing itself when some of the anhydride evaporates even before it takes part in the reaction. The analysis of a commercial resin cured with PA gave the following results which emphasize this surface effect:

Parts by weight of PA to 100 parts by weight of epoxy resin—

uncured resin mixture	30
on the inside of the cured casting	30
on the free surface (thickness of layer 0.01-0.02 mm.)	13

These results show that care is needed when taking samples and also when drawing conclusions from them. When making our investigations, therefore, we carried out a separate test in a sealed glass vial or a collapsible metal tube for every single value measured.

Reactions II and III

Reactions II and III are discussed together, since in most cases, it is the ratio of both which is of main interest to us. In contrast to Reaction I, both Reactions II and III are irreversible and as polyaddition of epoxy resin molecules they are responsible for the cross-linking processes.

The ratio of ether to ester formation depends on the following conditions:

(a) Reaction Temperature. An increase of reaction temperature shifts the ratio towards higher ester formation.

(b) Basic Additives. With basic catalysts such as amines[3,4] or alkali-metal salts[5,6] of carboxylic acids, which are used in admixtures with anhydrides, the reaction is also shifted towards greater ester formation. Ester formation is generally accelerated more by basic admixtures than ether formation. With the salts, no ether is even formed. This behavior is understood when the reaction is described ionically since the alcoholate ions will instantaneously change to carboxylate ions as long as acids are present. From an economic viewpoint such admixtures have the advantages of accelerating curing and permitting the use of larger quantities of cheaper anhydride hardeners as fewer epoxy groups are used for ether formation (Reaction III).

(c) Nature of Carboxylic Acids. Since ether formation is catalyzed by acids or anhydrides on one hand and ester formation is catalyzed by basic additives on the other, the question arises as to what extent the ratio of these reactions depends on the nature of the carboxylic acids. In order to answer this question, we treated equimolecular quantities of cresyl glycidyl ether with various carboxylic acids at 125° C. and then measured the ester and ether formation. The results obtained at a fixed extent of reaction are shown in Table 1.

Table 1. Uncatalyzed Reaction of One Mole of p-Cresyl Glycidyl Ether with One Mole of Carboxylic Acid at 125°C.

Acids	Reacted Epoxy, %	Reaction Time, Hrs.	Ether/Ester Ratio
Benzoic acid, anal., pure	95	35	0.50
Cinnamic acid, c.p.	95	41	0.25
Cinnamic acid, twice recrystallized	95	33	0.40
Acetic acid, distilled	95	96	0.18
Acetic acid, twice fractionated	95	38	0.30
o-Chlorobenzoic acid, c.p.	95	5	0.11
o-Chlorobenzoic acid, c.p., twice recrystallized	95	4.5	0.38
Lauric acid, anal., pure	95	>150	0.16
Lauric acid, twice recrystallized	95	110	0.24
Fatty acid of linseed oil, tech.	95	85	0.06
Fatty acid of linseed oil, tech., dist.	95	160	0.18
Phthalic anhydride, c.p.	40	72	0.85
Phthalic anhydride, c.p., twice recrystallized and sublimated	40	80	0.92

The differences exhibited in reaction velocity and in ether-ester ratio are considerable and it is quite impossible to express them in terms of a simple function of the acid dissociation constant. In view of the influ-

ence of basic additives, the purity of the acids is of paramount importance. Table 1 shows also that the cresyl glycidyl ether reacts with PA, although very slowly, and ether groups are formed to a marked extent, as reported previously.[1] We believe that this particular reaction with PA may be explained by the fact that impurities which contain active hydrogen atoms produce a small quantity of phthalic acid, which in its turn reacts with an epoxy group thus starting off Reactions I, II and III. Even when using thoroughly purified starting materials, the reaction takes place. Additions of small quantities of acid or hydroxyl groups do cause an acceleration, but the influence is less than anticipated and cannot be expressed by a simple mathematical formula.

Side Reactions

The esterification of a hydroxyl group with an acid group, during which the water formed brings about hydrolysis of epoxy, anhydride or ester groups, should be taken into consideration. It was shown, however, that these side reactions take place to a considerable extent only in an open system from which the water can evaporate, thus shifting the equilibrium towards the ester side. (Compare with the discussion under "Fundamental Conclusions, Reactions I-III," the section on "Volatile Compounds."

Complete Analysis of Curing Process and Cured Products.

The only groups which take part in Reactions I-III are hydroxyl, anhydride, monoester, epoxy, diester and newly formed ether groups. These six different groups can be determined by the use of analytical procedures and algebraic equations.

Algebraic Equations

Given that Reactions I, II and III take place exclusively, the following quantitative equations apply to the complete curing process:

(a) anhydride + monoester + diester = initial anhydride
(b) epoxy + diester + ether = initial epoxy content
(c) hydroxyl + monoester = initial hydroxyl content

Methods of Analysis

Test samples which have become insoluble are milled to a fine powder and put through a sieve of 2500 meshes per sq. cm. The samples are then mixed with appropriate reagents in the presence of a suitable swelling agent and the tests carried out, yielding the desired values directly or by appropriate calculation. In principle these methods are as follows:

(a) Epoxy Groups. Reaction with hydrobromic acid.
(b) Anhydride and Monoester Groups. Samples which are not completely cured are titrated with aqueous NaOH in the absence of alcohol on the one hand, and with sodium methylate in the absence of water on the other.

With fully cured samples the *anhydride* content is determined separately by extraction and filtration. The *sum of anhydride and monoester* contents is determined by treatment at 50° C. with sodium methylate in the presence of methanol (the resin dissolves as a result of transesterification with methanol).

(c) Ether Groups. Complete saponification by means of water-free methanolic KOH and determination of the esterification equivalent of the resulting polyalcohol is used for ether groups. The calculation is based on the fact that according to Reaction III, each reacted epoxy group corresponds to two ester equivalents which have disappeared while the hydroxyl content does not change.

For the six above mentioned variables there are three algebraic equations and four methods of analysis that may be used and it is possible, therefore, to check results by different methods. The values obtained by the various methods were found to correspond satisfactorily.

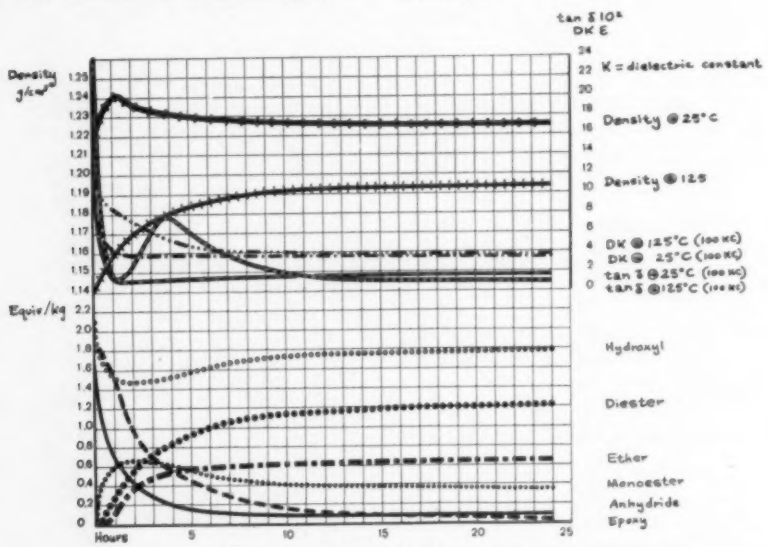


Figure 1. Physical and chemical changes during the curing process.

Tests on Commercial Resin

An epoxy resin,[##] 100 parts by weight (pbw), containing 2.5 epoxy and 2.8 hydroxyl equivalents per kg. were reacted at 125° C. with 31.4 pbw of PA (0.85 anhydride equivalent per epoxy equivalent). For each value a separate test was carried out in a sealed glass vial or a collapsible tin tube.

Chemical Test Results

The results of the chemical tests are shown in the bottom half of Figure 1. The concentration curve of the single groups is as anticipated. It is interesting to note the temporary maximum of the monoester or the minimum of hydroxyl groups resulting from an overlapping of Reactions I and II.

The cured resin consists of a large proportion of hydroxyl groups, less monoester groups, and a smaller amount of anhydride, besides the cross-linking diester and ether groups.

Physical Properties

The top half of Figure 1 shows curves for density and dielectric properties at 100 kc., both at curing and at room temperatures, with time. All of the curves for both chemical and physical properties in Figure 1 level out at about the same time after ten hours, so there is no apparent contradiction between the chemistry and the physics of the curing reaction. At curing temperature, the rapid decrease in hydroxyl, anhydride, and epoxy contents during the first few hours runs parallel with rapid decrease in dielectric properties. The dissipation factor shows a maximum at 125 ° C. after about four hours. To obtain a detailed analysis of the dielectric properties, a comprehensive determination of the temperature and frequency dependence must first be made.

The course of the density curves is a source of surprise. The curve at 125° C. shows a continuous rise with time and then levels off slowly. The curve for samples brought down to room temperature and showing no signs of crystalline PA when analyzed by X-ray, exhibits in contrast, a rapid increase in density which reaches a maximum after about one hour and then starts to decrease. Such action indicates a *negative shrinkage*, or expansion, during curing.

Curve of density versus temperature for a casting resin during the curing process with the time factor omitted for the sake of simplification, are shown in Figure 2 and will be described in some detail. The right ordinate shows the *linear shrinkage* expressed in percent and referred to the cured resin at 20° C.

We shall first study the course of the curve through points ABCDEF. The uncured resin and PA mixture, extrapolated at a room temperature of 20° C., shows a density of 1.229. Assuming that the heating up to the curing temperature is carried out so rapidly that no reaction can take place, the change in density with increasing temperature is linear, according to the following equation:

$$D_t = 1.229\ [1 - 6.8 \times 10^{-4}\ (t - 20)]$$

If curing is carried out at a constant temperature of 120° C., as shown in Figure 2, for example, density will continue to increase until curing is completed (point D). When the cured resin is cooled down to room temperature, two different expansion or contraction coefficients have to be taken into consideration. Down to about 105° C. (point E) the change in density takes place according to the equation:

$$D_t = 1.205\ [1 - 5.0 \times 10^{-4}\ (t - 110°\ C.)]$$

Below 105° C., the density change takes place according to the equation:

$$D_t = 1.231\ [1 - 2.2 \times 10^{-4}\ (t - 20°\ C.)]$$

The point E of the intersection of the two straight lines is, according to definition, the second order transition point. At 20° C., the densities of the uncured and cured mixtures are practically identical. If it were possible to cure at this temperature, the total shrinkage value would be ideal, that is to say, practically zero. If curing could be carried out at 0° C., there would even be a negative shrinkage of expansion of approximately 1% by volume. From the point of view of application, a distinction should be made between density changes; (a) in the liquid phase, and, (b) those in the gelled or solid phase.

As long as the density changes take place in the liquid phase, no internal stresses can occur. In the gelled or solid state, however, stresses can always appear and they are inevitable if materials which do not have the same thermal coefficient as the resin, are embedded in it. In our resin mixture the isothermal shrinkage due to curing is distributed about evenly between the liquid phase and the gelled or solid state. A so-called "gel line" is drawn, therefore, in Figure 2. The technically important shrinkage, i.e., that which might cause stresses, appears below this gel line. This shrinkage is represented by the line CG.

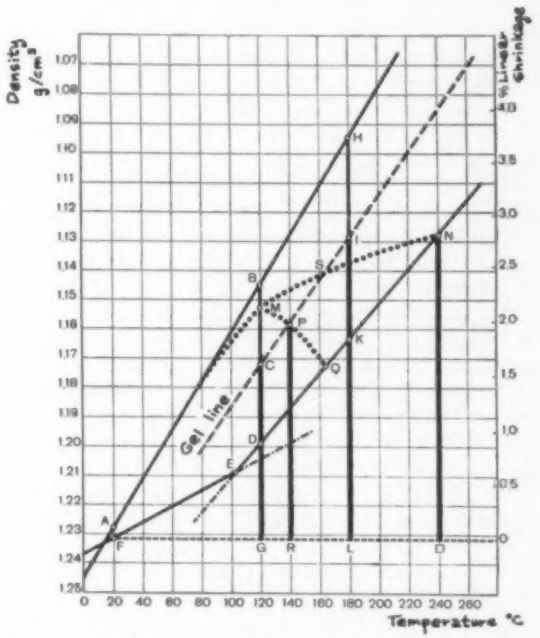


Figure 2. Density changes during the epoxy resin curing process.

[##] Araldite 6060, CIBA Products Corp.

Shrinkage at any curing temperature can be read from Figure 2. For example, if the resin is cured at 180° C., the density curve passes through points AHIKEF and the shrinkage in the solid phase is represented by the line IL.

The above observations are only valid if the heating up time is very short and if curing is carried out at a constant temperature. In practice, this is feasible when processing small quantities of resins. In the case of larger castings a partial chemical reaction takes place during the heating up period, and it is impossible to avoid an exothermic reaction. These circumstances are taken care of in Figure 2 by the broken lines. Up to 120° C. the density curve is not linear to point B but goes directly to point M. From this point on, the following cases of exothermic reactions are to be considered:

(a) The reaction that is very fast exothermically so that after having gone through the gel line the decrease in density caused by rise in temperature is greater than the increase in density caused by chemical reaction. The shrinkage in the solid phase is determined by the maximum temperature (line NO).

(b) The type of reaction whereby after having passed the gel line, chemical shrinkage is greater than expansion caused by rise in temperature. The density shows a continuous increase and a rise in temperature no longer causes a rise in shrinkage.

Shrinkage in the solid phase in (b) above is not determined by maximum temperature but by the temperature at the intersection of the gel line (point P) and the shrinkage is represented by the line PR. In order to achieve low shrinkage, the exothermic reaction should be contrived, if possible, as follows: (a) It should pass the gel line at the lowest possible temperature. (b) After having passed the gel line, the reaction should proceed slowly so that chemical shrinkage is always greater than thermal expansion caused by rise in temperature.

Cured Resin Chemical Structure Dependence on Curing Temperature

Figure 3 shows the influence of the temperature dependence of Reactions I-III on the chemical structure of the cured resins.

As the curing temperature rises the hydroxyl and diester content increases, while the other values decrease correspondingly.

The analysis of the cured resin leads, therefore, not only to information concerning chemical structure but also to the post curing temperature applied to a given resin.

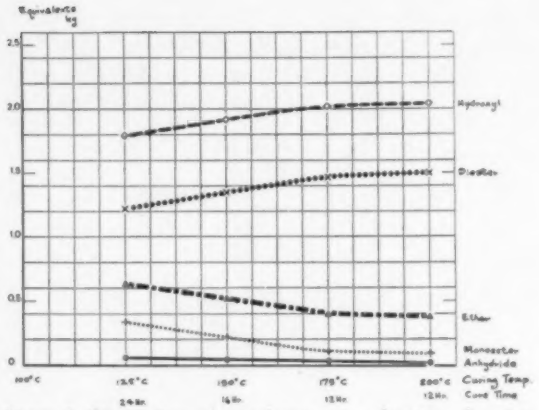


Figure 3. Composition of cured resin as a function of curing temperature.

Summary and Conclusions

New methods of analysis show all the factors arising during curing as they relate to the structure of cured epoxy resins. These latter include epoxy, hydroxyl, anhydride, carboxylic and diester content and the newly formed ether groups.

Tests on a cured commercial resin disclose that it consists of a large proportion of hydroxyl groups, and smaller amounts of monoester and anhydride groups in addition to the cross-linking diester and ether groups. At curing temperature the rapid decrease in hydroxyl, anhydride and epoxy contents runs parallel with rapid decrease in dielectric properties. The density of specimens measured at room temperature indicates a maximum at the onset of curing.

In the curing of large castings, the density curve with temperature is not linear because of exothermic reaction. In order to achieve low shrinkage, the exothermic reaction should be controlled so that it passes the gel line at the lowest possible temperature and then proceeds slowly so that chemical shrinkage is always greater than thermal expansion caused by rise in temperature.

As the curing temperature is increased from 125° to 200° C., the hydroxyl and diester content of the cured resin increases while ether, monoester and anhydride contents decrease correspondingly.

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—THE END

IRVIN I. RUBIN*

What's wrong with machine instruction manuals?

One of the trickiest problems to solve in writing an article, report, or text is knowing your reader—his capabilities and limitations. Machine instruction manuals, as the author points out, are all too often pointed at the wrong audience. Here is an area, so important in terms of repeat sales and customer satisfaction, which is sadly neglected. Operating and maintenance personnel are not design engineers, and yet they are expected to interpret the vaguest generalities about complex machinery. A suggested machine manual and its inclusions are described.—Editor.

The instruction manual is a very important part of a machine purchase. It is no exaggeration to state that in many plants the utility and reputation of a machine have been severely damaged due to limited and ineffectual information in the manual. The purpose of a manual is to acquaint engineering, operating and maintenance personnel with the machine—primarily the latter two. Operating personnel will probably absorb enough information during the initial start up, even without the manual, since most manufacturers send a service man to supervise this operation and give preliminary instructions.

The finer points are learned by a combination of experience and the information available in the manual. Maintenance personnel depend almost completely on the manual, and it is primarily for these people that the manual should be written. It should provide clear concise information which is almost never referred to except in emergencies. Then, these virtues are paramount.

The attitude of maintenance and operating personnel has a lot to do with a machine's usefulness. Too often, an excellent machine or piece of newly designed equipment gets a poor rating because these men are not familiar with them and have neither the ability nor the tools (an adequate manual) to cope with them.

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The make up and abilities of the average maintenance department in molding plants should be understood by manual authors. There are no schools for their training, yet they must be familiar at least with hydraulics, mechanics, electricity, machine shop practice, plumbing, and welding. They have learned by experience rather than theory and, therefore, tend to dislike and resist what is difficult to understand. This point is not always appreciated by machine manufacturers, who too often stress the service man. The plant maintenance department is reluctant to call outside help, considering it a reflection on their ability.

Engineering and sales personnel from the machinery firm rarely encounter operating and maintenance personnel. Their main contacts are with engineers and management whose approach to a machine is different from those who operate and maintain it. Many plants lack engineers and/or professional maintenance men. The maintenance department head usually has this training, but the average maintenance man and shift foreman are much less knowledgeable. They usually try to compensate for this lack through experience and resourcefulness. Given adequate instruction manuals, they can readily service the overwhelming majority of machines now in operation.

In the course of writing a book on injection molding I have had occasion to see the instruction manuals of almost all American machinery manufacturers plus a considerable number of foreign ones. They range from superb publications entailing a great deal of thought and understanding down to a few amateurish drawings with badly reproduced and sometimes illegible text. This had led me to make the following observations and suggestions:

The instruction manual should be available in duplicate; one for the permanent file, and the other to be used in the shop on the job. In this way, soiled or damaged sections can be reproduced from the original without contacting the machine manufacturer. The quality of the paper used for drawings should be adequate to resist tearing and smudging. One should be

able to write on them and erase at will. Legibility is most important. Many of the prints are reduced in size to the point where they are difficult if not impossible to read, and no room is left for notations. If this is necessary within the manual itself, why not make available 1 or 2 large sets of diagrams?

Here is a list of drawings which I feel should accompany the machine:

1. An overall drawing giving machine dimensions and information required for installation. Preferably, this should be a separate print which can be given to the contractors or personnel installing the machine.

2. Drawings or photographs of the machine locating all parts by identification number and name (this includes limit switches, valves, etc.).

3. Platen drawings showing both platens with mounting holes or slot locations, knock out location, maximum and minimum opening dimensions, and information on sizing special nozzles. The knock out arrangement should conform to SPI injection machine standards, since most molds are built in accordance with them. Otherwise, extensive alterations may have to be made on incoming molds. The drawings should be reproducible so that the molder can make additional copies to send the moldmaker.

4. The heating cylinder plunger and bushing drawings should give complete dimensions, with the material and heat treating specification indicated. If the cylinder is plated, it should be indicated. This is a very useful drawing to have, particularly if the shop is equipped to handle its own repairs.

5. Electrical diagrams for the heating cylinder should include the specifications of the heating unit, thermocouple location and size, and any special instructions for installation of tubular heaters or other devices.

6. A fully dimensioned drawing of the standard nozzle with a list of material and heat treating specifications. The maximum and minimum length of the nozzle should be indicated.

7. An electrical schematic drawing using JIC Graphic Symbols. Machinery manufacturers should adhere to these conventions scrupulously. I have seen drawings using the JIC designations for pneumatic timers when motor driven timers were used on the machine.

8. An electrical wiring diagram showing the location and numbering of all wires. Unfortunately, the men manufacturing the machine will sometimes make wiring shortcuts not shown on the diagram. The molder should insist that the diagram conform to his particular machine.

9. A drawing of the electrical panel layout with dimensions. Often, local codes require the addition of fuses to the motor overload protective devices. The molder may want to make circuit changes, and dimensions are very helpful at this time.

10. A listing of the limit switches, their identification number, function, location, and what activates them. This, too, is usually included within the manual. If you have ever tried to thumb back and forth in a manual to locate limit switch, relay, timer, and hydraulic-component functions, while checking the electrical and hydraulic diagram, you appreciate the value of having this and similar information on separate sheets. If the electrical and hydraulic diagrams are large enough, this information might be put next to the limit switch or other components where it is most needed.

11. A table of switches, their identification number, function, location and contact arrangement.

12. A list of timers, their identification number, function, location, contacts, contact sequence, what energizes them, what starts them, and what resets them.

13. A table of relays with their identification number, function, location, number and type of contacts, and the method of energizing and deenergizing the relay coil.

14. A master table showing the operating conditions of all electrical components at each change in the cycle. It could follow this format:

	Gate Open	Gate Closed	Clamp forward Low Pressure
Unit Switch 1 (safety gate front)	—	×	×
Unit Switch 2 (Safety gate rear)	—	×	×
Timer 1 (Clamp)	—	—	×
Timer 2 (Injection)	—	—	—

× = Activated

15. A drawing showing electrical test points, their function and location. This might be incorporated in the electrical diagram.

16. A hydraulic diagram with the JIC graphic symbols. Some manufacturers also include a JIC cut-away diagram, which is good but should not be at the expense of eliminating the JIC graphic symbols.

17. A hydraulic layout diagram showing the piping and components.

18. A table of the hydraulic components, their number, name, function, and location including test points for gage insertion and flow determination.

19. A master table similar to 14 showing the positions of all hydraulic components at each change in the cycle.

20. Locations of all lubrication points. The type of lubricant and suggested frequency of lubrication should be indicated.

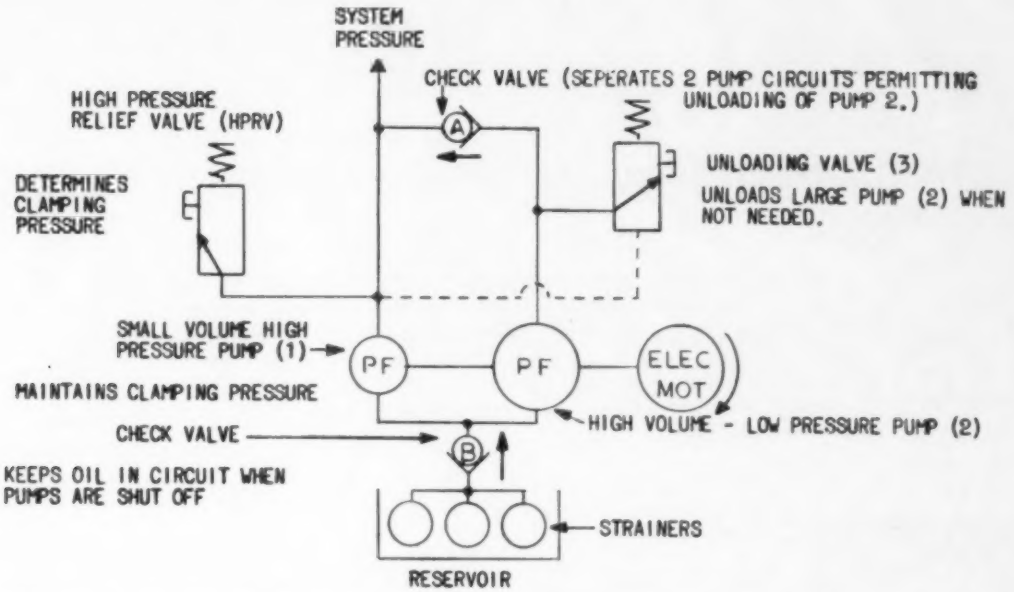
21. A maintenance schedule. This is often included in the manual but not as a separate print which would be preferred.

22. Any other prints with dimensions, tolerances, material, and hardening specifications on parts that might have to be repaired by the molder. These might include brackets, feed mechanisms, toggle parts, etc.

The manual should list all the components of the molding machine with the part identification number assigned to it by the manufacturer as well as the OEM component part number and designation. This holds for all hydraulic, electrical, and mechanical parts required. It should include location, size specification, and manufacturer's number of all packing used on the machine.

A list of suggested spare parts, realistically drawn, should be included in the manual. For example, a

** Numbers and letters in parentheses correspond to numbers in Figure 1.


SYSTEM PRESSURE
CHECK VALVE (SEPERATES 2 PUMP CIRCUITS PERMITTING UNLOADING OF PUMP 2.)
HIGH PRESSURE RELIEF VALVE (HPRV)
DETERMINES CLAMPING PRESSURE
UNLOADING VALVE (3)
UNLOADS LARGE PUMP (2) WHEN NOT NEEDED.
SMALL VOLUME HIGH PRESSURE PUMP (1)
PF
PF
ELEC MOT
MAINTAINS CLAMPING PRESSURE
HIGH VOLUME - LOW PRESSURE PUMP (2)
CHECK VALVE
KEEPS OIL IN CIRCUIT WHEN PUMPS ARE SHUT OFF
STRAINERS
RESERVOIR

complete set of packings should be purchased with the machine, plus extra sets for some parts. It is good maintenance practice to replace packing in many components when they are disassembled or overhauled. It is also good to have extra limit switches, timers, overload heating elements for the motor control and starting circuits, heating bands or tubular heaters used on the heating cylinder, and hydraulic fittings. A list of special tools required is desirable.

Special instructions for repair, dismantling, and reassembling machine parts should be included. Instructions, exploded views, parts identification for hydraulic and electrical components and other assemblies should be provided. This is exceptionally important as, on more than one occasion, a maintenance man has reassembled a valve incorrectly because he forgot how he took it apart.

Parts should be referred to in the manual not only by the number but by name. This makes identification easier and forms a basis for continuity in the thinking of the maintenance man. The identification numbers on the blueprints should be attached to the components on the machine. While an experienced hydraulic engineer can easily differentiate a relief valve from a sequence valve or unloading valves, the maintenance man will probably be a lot less familiar with them and appreciate seeing an identifying number.

When used, JIC symbols should be illustrated and explained. I am certain that the vast majority of maintenance personnel are not as familiar with them as they might be and, therefore, require this information. It might also be a good idea to include pertinent parts of the JIC hydraulic and electrical standards. Circuits should be explained in simple terms on the assumption that the repair man has a minimum of training. The circuits should be broken down and explained, even at the expense of redrawing them. For example, the electrical circuits should be broken down into the motor control circuits, heating circuit, and the operating circuit. The operating circuit should actually be broken down still further. The same is true for the hydraulic circuit.

As an example, let us use the Hi-Low pressure circuitry found on most molding machines using dual fixed displacement (volume) vane pumps as their power supply. In addition to having the circuit on the master hydraulic diagram, it might be reproduced as a separate unit and explained by itself (see Fig. 1).

The oil is pumped by two separate pumps combined on one shaft and driven by an electric motor. One pump, the holding pump, provides a small volume at high pressure (1)**, and the other (2) large volume at lower pressure. They are fed from the reservoir through common strainers (which remove solid contaminants) and check valve (B). This check valve permits oil to flow only in the direction of the arrow and prevents oil in the circuit from draining back when the pumps are not running. The small-volume high pressure holding pump (1) has its maximum pressure controlled by the high pressure relief valve (HPRV). A screw controls the spring compression in this valve. When the spring force is overcome by the oil pressure, a spool inside the valve shifts, allowing enough oil to by-pass into the tank to reduce the pressure to the preset value. The spool then shifts back, closes the valve, and repeats the cycle as often as necessary.

Oil from the high volume-low pressure pump (2) feeds into the system through check valve A. This prevents oil from the high pressure pump (1) from flowing into its circuit. An unloading valve (3) is connected to the high volume-low pressure pump (2) circuit. It is piloted (controlled) by the pressure from the small pump (1). When oil in this line reaches a pressure of 400 psi. (the setting of this particular unloading valve), a spool shifts by-passing all the oil from the low pressure pump (2) to the tank. This permits the large volume pump (2) to dump the tank when not needed without affecting the other pump (1).

(*Continued on page 44*)

Thermoforming—processes and applications

The basic principle of thermoforming actually predates recorded history, but only the development of improved thermoplastics materials and equipment are permitting the technique to achieve its potential. The article points out the unique features of the process which make it ideal for certain applications, restrict it in others. It's a process which certainly bears looking into by the processor seeking new applications for plastics.—Editor.

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Developments in thermoforming might be likened to the growth and development of Africa. Until recently, too few people were aware of its importance and potential. Although one of the oldest methods of forming thermoplastics, the technique was soon replaced by injection molding for any long-run item. Its use was largely restricted to short runs, which could be produced at relatively low cost since mold and other equipment costs were low.

The past few years have altered this trend of thought considerably. New forming materials have been introduced which, in turn, have encouraged the development of new forming machines and automated techniques. Here are but some of the current applications: refrigeration—door liners, food compartments, and crisper trays; packaging—contour and blister packs, lids, and containers; automotive—air ducts, crash pads, and arm rests; signs and displays; military—contour maps and airplane canopies; and industrial—machine housings, tote boxes, and furniture components.

The thermoforming process has many unique features when compared to injection moldings, some of which are advantages. Others are limitations. First, let's consider the pro side: Low mold and equipment costs allow formed parts to be produced in small quantities at relatively low cost. These lower mold costs allow greater design freedom, since even multiple molds are relatively inexpensive. Large area parts are easy to form, even in thin-wall (0.015-inch and under) sections. Toughness is maintained, and sheet can be laminated or preprinted to achieve unusual decorative and protective finishes.

Here are the limiting factors: Since sheet is required, its cost must be considered in the overall cost picture. Trimming leaves scrap which may or may not be reclaimable. It is difficult to obtain sharp detail on thick-walled parts on the side opposite the mold, and impossible to obtain parts with abrupt changes in wall thickness around certain ribs and bosses. Deep draws and sharp corners may pose problems and it is difficult to eliminate markings and mold drag lines on parts made with positive male molds.

The forming cycle

Almost all thermoforming operations follow a set cycle regardless of end product size: heating the sheet or film, forming the article, cooling, and trimming (this step may come first or be eliminated, if the sheet is cut to exact size before forming). There are a number of ways each of these operations can be accomplished, the most popular of which will be discussed in this article.

Heating

Generally, thermoplastic sheet should be heated rapidly to the forming temperature with a minimum temperature gradient through the sheet and from edge to center. An exception would be an expanded, closed-cell sheet which should be heated slowly to prevent over-expansion with subsequent cell collapse. Factors affecting heating time include type and intensity of heat source, required sheet temperature, sheet absorption characteristics, specific heat of the sheet, its thermal conductivity and degradation characteristics.

The degree of heat control required will vary with the type of material and amount of orientation induced during sheet manufacture. Materials with a wide softening range (impact polystyrene) do not require as much control as do the polyethylenes, which have sharp melting points. Some plasticized materials require sharp temperature control, since rapid or excessive heating can cause internal vaporization of vola-

tiles. This results in blistering or excessive exudation. Oriented stock requires a higher clamping pressure to avoid shrinkage back to original dimensions on the application of heat.

RADIANT HEATING. The most popular method of bringing sheet to its forming temperature, it uses infrared rays at temperatures of 500-1,700° F. With thin, transparent sheet, much of the radiant energy passes through without being absorbed thus requiring a reflecting shield. Ten-mil opaque material absorbs all the radiant energy; however, pigments affect heating time much less than might be expected.

Since most plastics are good insulators, there is danger of overheating with subsequent material degradation and color change. Sandwich heating minimizes this possibility, and has the added advantage of reducing heating time. Distance between heaters and sheets is usually kept at a minimum to reduce edge losses, with 6-8 inches being considered the minimum for rod and spot heaters.

CONVECTION HEATING. This involves an air-circulating oven and is an excellent method for obtaining uniform heat distribution and accurate temperature control. Unfortunately, this is a slow method although several sheets can be heated simultaneously. This poses other complications, however, since materials other than acrylics and ABS tend to stretch or sag if allowed to remain at their forming temperature for more than a brief period.

CONDUCTION HEATING is often referred to as platen or contact heating because the sheet is held in contact with a heated, polished metal surface or surfaces. As a variant, air pressure holds the sheet against the heated platen and reverse air pressure frees it when the forming temperature is reached (See Fig. 1).

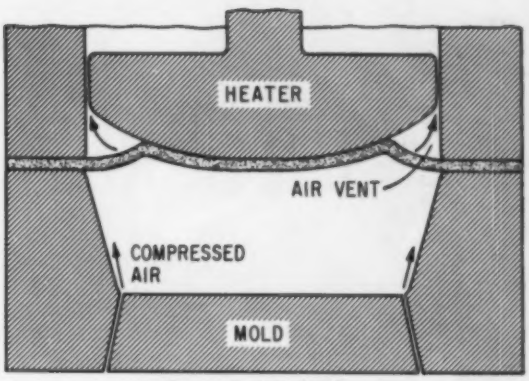


Fig. 1. Contact heating.

Forming

Basically, all forming includes movement of the heated sheet by air (pneumatic) pressure, by mechanical drawing, or by a combination of the two. Air pressure may range from almost zero to several hundred psi. In normal vacuum forming, atmospheric pressure is utilized by evacuating the space between the sheet and the mold. This gives satisfactory reproduction of mold configurations in most cases. When higher pressures are required, a chamber is sealed to the top of the sheet and pressure is built up within by compressed air or steam. This system, called pressure forming, is used to obtain detail with oriented materials and those with high hot strength. Only slight equipment modifications are required.

Mechanical stretching aids material distributed before air pressure forming, and may be accomplished by drawing sheet over a positive mold or forcing it into a cavity with a plug. Pneumatic stretching to a balloon shape before mechanical stretching gives three steps: blowing the balloon, mechanical stretching, and forming to the mold by air pressure.

Straight forming

The least complex technique is known as straight or cavity forming. Heated sheet is clamped over a cavity or mold box and pneumatic pressures force the sheet against the mold. A positive mold can be used inside a mold box (See Figs. 2 & 3). Sharpest detail is obtained on the mold side, and thinnest sections are at the bottom corners. Parts with vertical walls or with slight undercuts release easily since the plastic shrinks away from the mold on cooling. Cavities can be placed close together in multiple molds without dangers of webbing.

Free forming

In free forming the heated sheet is clamped over a mold box which is evacuated only slightly. This causes a blister or inverted dome to form without bringing the sheet in contact with the mold box except at the edges where it is clamped. If air pressure is used, the process is called free blowing. Blemish-free parts are produced having exceptional surface finish.

Drape forming

Deep draw parts are often inverted and drape formed over a positive or combination mold. Heated sheet is mechanically pre-stretched over the mold before forming by air pressure. On completion of mechanical stretching, the sheet is drawn over the edges of the

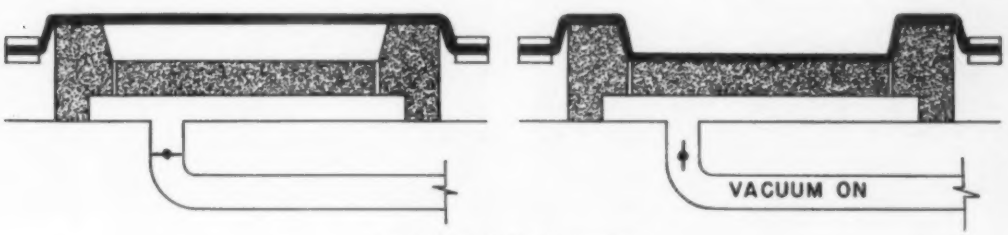


Fig. 2. Straight forming - vacuum.

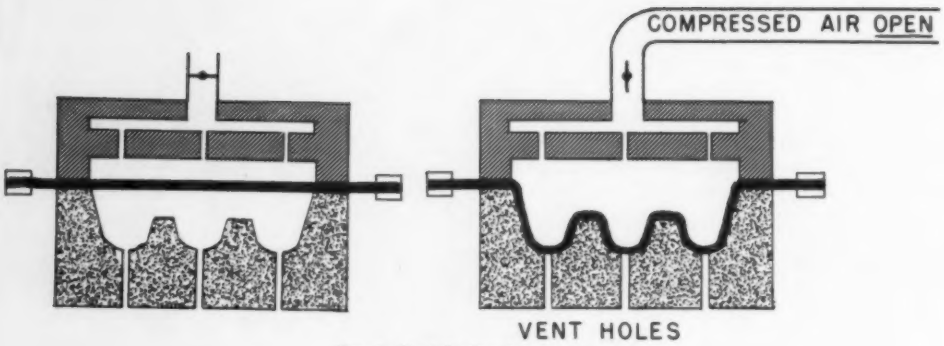


Fig. 3. Straight forming - pressure.

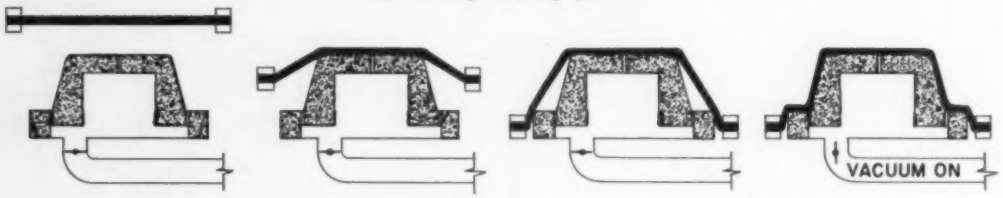


Fig. 4. Drape forming. PRESTRETCH FORM

mold platform to obtain a seal. The space between sheet and mold is then evacuated (See Fig. 4).

Sharpest detail is found inside the part, the side which was next to the mold in drape forming. The thickest section is at the top; the thinnest at the corners joining the mold side wall and base. Drag or chill lines often appear on the side of the part, indicating a rapid change in material thickness. The chilled sheet is usually drawn slightly during the remainder of the draping operation, therefore, the drag line appears near the top.

Positive molds used in drape forming must have sufficient wall taper to prevent locking as the sheet shrinks during cooling. Rigid materials require greater taper, as flexible sheets can actually be stripped from the mold if necessary. Webbing and bridging can generally be controlled by using a grid or ring assist. The rings are placed on the upper clamping frame and act as individual drape frames, especially when multiple molds are used (See Fig. 5).

Plug and ring forming

A forerunner to drape forming, it uses a draping action between die sections without additional pneumatic forming. Tooling consists of a positive mold and a ring or clamping frame which matches the contour of the mold base. The heated sheet is held in the ring and the mold is forced through it, thus drawing the sheet to the contour of the mold (See Fig. 6). The process is little used today.

Slip forming

A variation of plug and ring, uses a slip ring which holds the sheet loosely. An oversized sheet is placed on the spring-loaded slip ring as the ring is drawn over the mold. Material slides down through

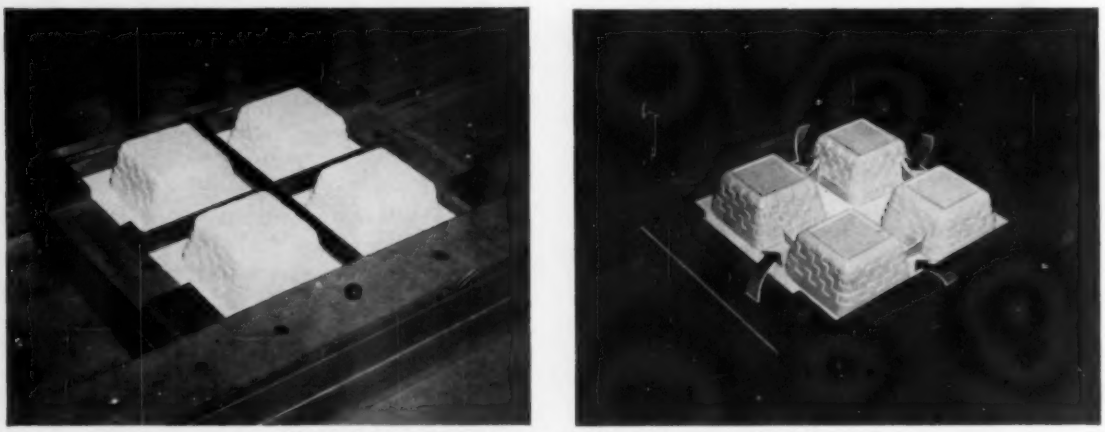


Fig. 5. Grid or ring assists are placed on the upper clamping frame and act as individual drape frames.

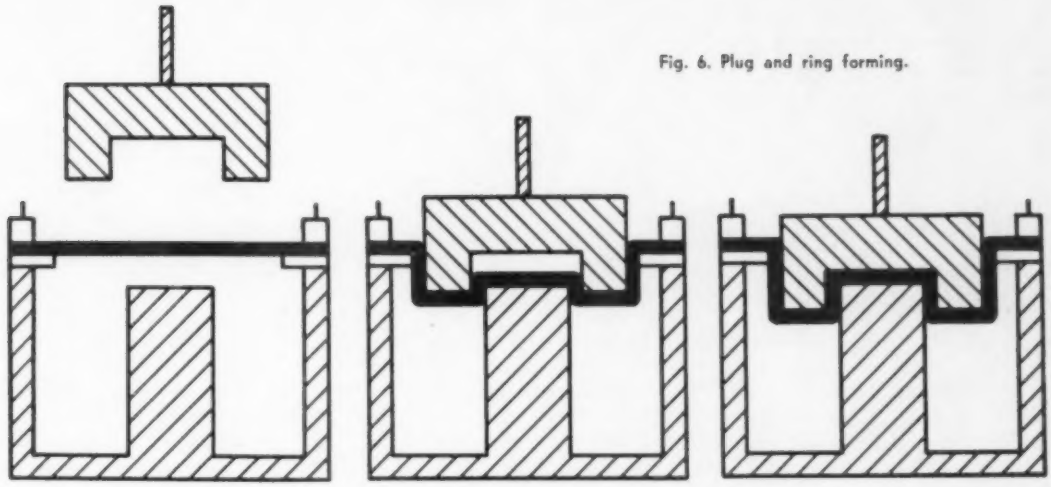


Fig. 6. Plug and ring forming.

the ring giving it a drawing action. The ring approximates the mold base contour; therefore, no further forming by differential air pressure is required. The process is limited to simple shapes made with materials of above normal hot strength.

Snapback forming

Pneumatic pre-stretching aids in overall material distribution with drape or plug and ring formed parts. In snapback, the heated sheet is drawn slowly into a vacuum chamber to a predetermined depth by a slight differential pressure. Once the bubble has been drawn, the mold is brought down until its edges seal on the box. The vacuum is then released and the sheet allowed to snap onto the mold, which is vented for air escape. The mold top, too, must be vented (See Fig. 7).

Reverse draw forming

The equipment is virtually the same as snapback, but material distribution in the formed part may be very different. The bubble or balloon is reversed, the heated air is introduced into the chamber, and the sheet is billowed upwards. The mold is lowered into the bubble until it seals onto the chamber, and the pressure is built up until the sheet conforms to the mold shape. The mold, here, must also be vented (See Fig. 8).

Air slip forming

Sheet is clamped to the top of a vertical wall chamber and the prebillow is achieved by a pressure build-up between the sheet and mold table as the mold rises in the chamber. The edges of the mold table are gasketed, the table acting as a piston within the chamber wall. On stroke completion, the space is evacuated and the sheet formed against the mold by differential pressure (See Fig. 9).

Plug assist forming

Both straight and drape forming are combined to give parts with uniform material distribution and which are easily removed from the mold. Heated sheet is clamped over the mold and carried down into the cavity by the plug. As the plug enters the sheet, the air beneath is compressed causing the sheet to billow up around the plug. Blowing action prevents the sheet

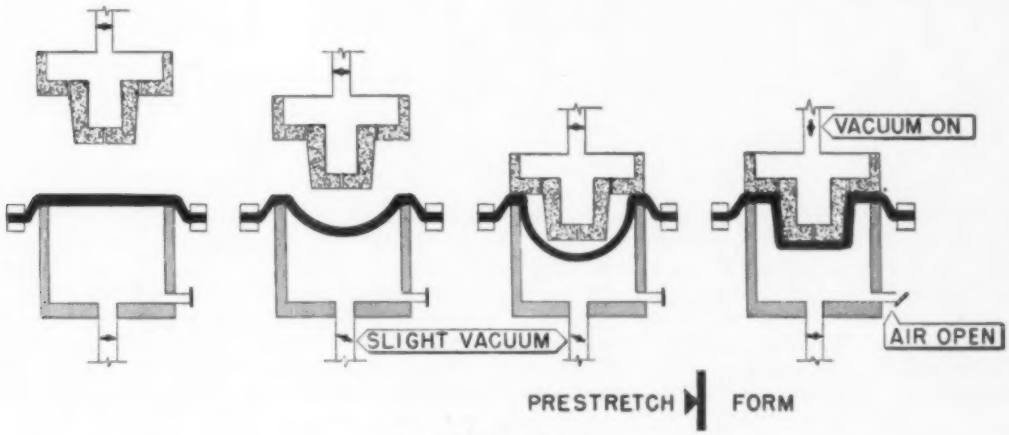


Fig. 7. Snapback forming.

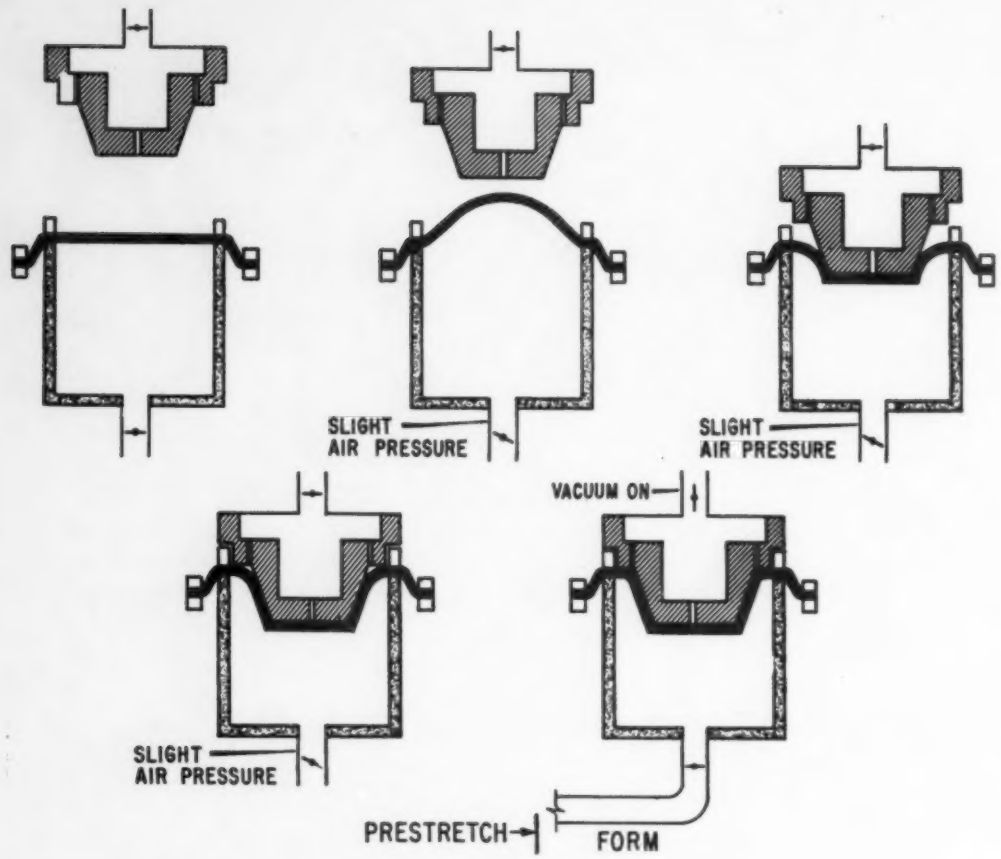


Fig. 8. Reverse draw forming.

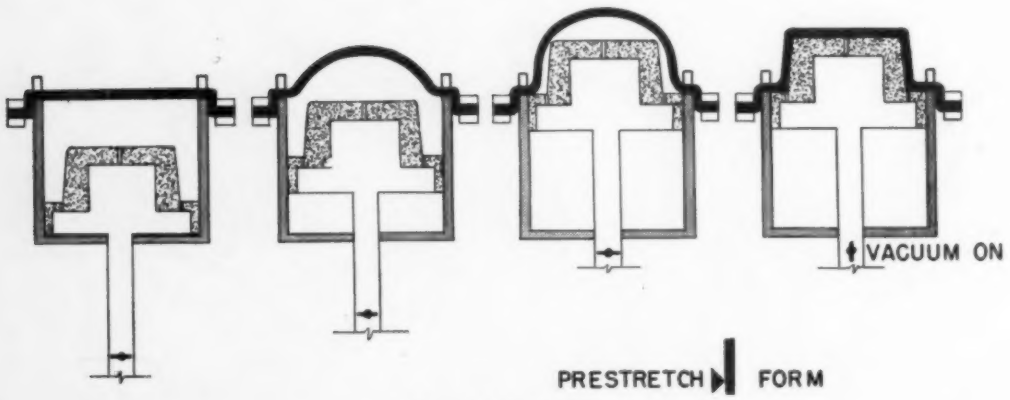


Fig. 9. Airslip forming.

from contracting the cavity lip as it is drawn in. The plug stops near the mold bottom, the mold is evacuated, and the sheet transferred from the plug to the mold by differential air pressure (See Fig. 10).

Plug size represents 70-90% of the cavity volume, regardless of size. Therefore, clearance between plug and cavity increases with part size. The radius between the bottom and side wall approximates that of the container, and may be quite sharp in small containers. Plugs are often made of conductive materials such as aluminum for consistent temperature control. By heating the plug to the forming temperature, a partial sticking will occur thus allowing an excess of material to be carried down into the lower cavity. Controlled depth of penetration permits more uniform material distribution in this area on subsequent draw-off.

Speed of plug penetration is also important, as it affects both material distribution and drag lines. Adequate platen pressure minimizes plug slowdown. Properly controlled, the billowing should take place from

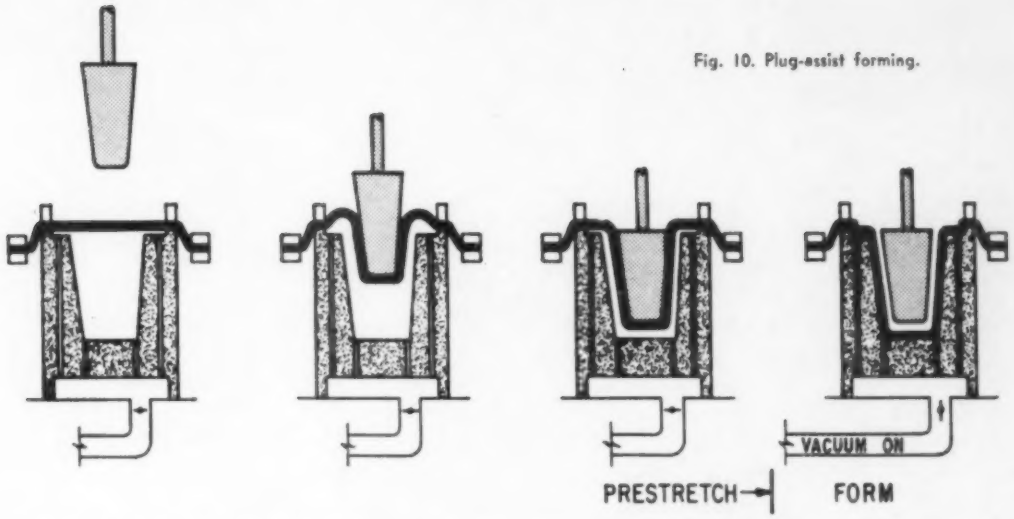


Fig. 10. Plug-assist forming.

the start of plug movement until it is stopped. It occurs because air in the mold cannot escape through the vent holes as fast as it is displaced by the plug. The amount of billowing, therefore, is controlled by the area of sheet clamped to the mold, plug speed, ratio of vent holes to container volume, and the differential pressure across the vent openings. Most production molds may require a large number of vent holes plus a vacuum bleed-off line which bypasses the main vacuum shut-off valve. This bleed-off should have a regulating valve which is timed to open as the plug enters the sheet (See Fig. 10).

Plug assist—reverse draw forming

For forming large-area, deep-drawn parts plug penetration can be preceded by a pressure build-up beneath the sheet causing it to balloon upwards. This eliminates

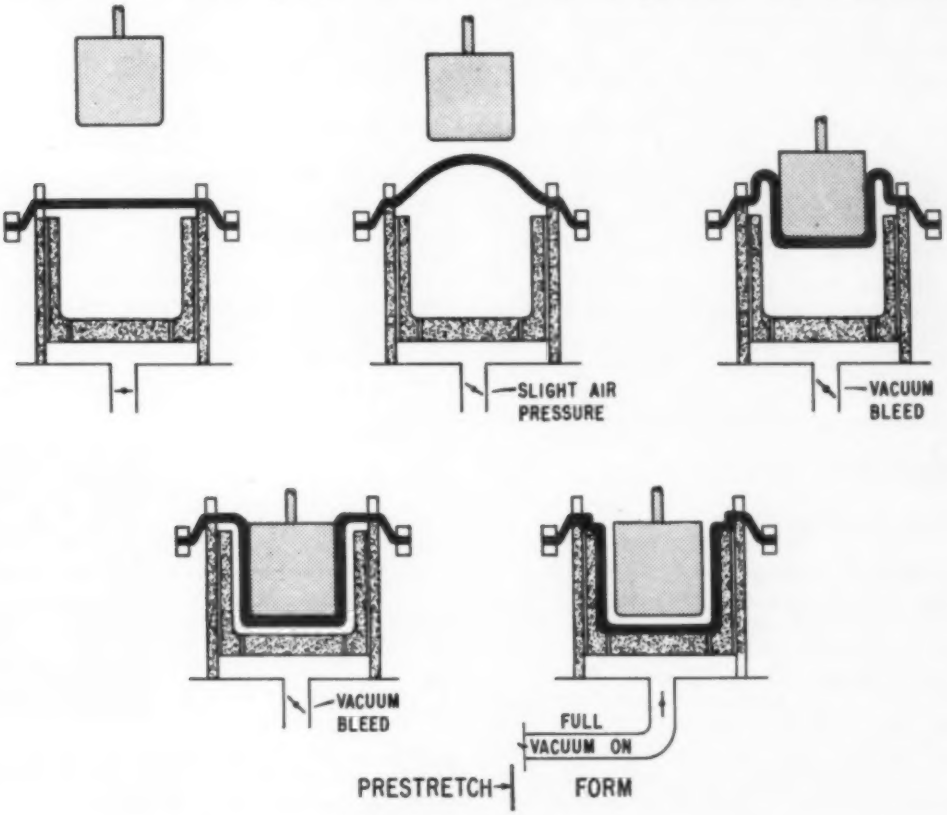


Fig. 11. Plug-assist - pre-blow.

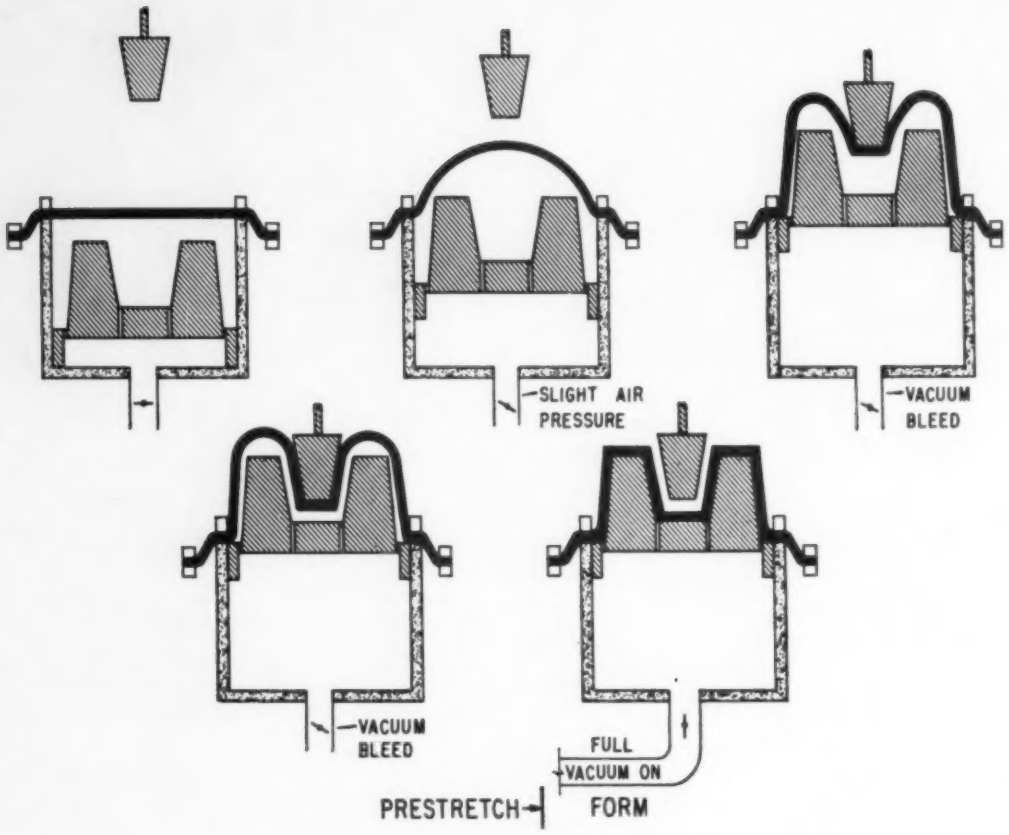


Fig. 12. Airslip - plug-assist combination.

any sagging at the bottom and makes the load build-up on the plug more gradual (See Fig. 11).

Air cushion forming

Here, air is introduced through the plug as it enters the sheet. Sticking or dragging is thereby reduced. The process also improves material distribution, especially by eliminating sag across the plug bottom as it enters the cavity.

Plug assist—air slip forming

This combination appears ideal for forming high-ridge positive shapes with deep cavity sections. The sheet billows upward as the mold rises. Just before the upper ridge of the mold strikes the bubble, the plug is introduced from the top reshaping the bubble to accommodate the mold ridge and carry material into the cavity (See Fig. 12).

(Continued next month)

Reinforced plastic casting forms

Reinforced plastic mold for concrete beam.

Casting prestressed concrete beams in reinforced plastic forms overcomes traditional limitations on design of structural beams and panels. Resco, Inc. developed the forms using Archer-Daniels-Midland resin reinforced with fiberglass, and Prestressed Concrete, Inc., fabricated 28-foot beams which were used in a suburban Minneapolis high school.

Aropo17510 resin resisted shrinkage under the combined heat of concrete curing with steam and the heat given off by the concrete as it solidified. One of the big advantages of the forms are the lack of seams, whatever the length of mold. Because surface textures as well as intricate design can be applied to this type of form, it is adaptable to panels and columns as well as domes and other irregular surfaces.

The conscientious salesman

PAUL E. FINA, Director of sales engineering, Fiberite Corp.

There are as many definitions of Salesmanship as there are sales managers. Each sales manager has developed himself primarily to sell certain types of products using methods which best fit the program or policies of his company. Although one specific definition may be entirely correct for a certain line or field, it may not be in another. Some definitions generally heard include: "—the art of persuading people, in the least amount of time, to purchase goods giving them satisfaction;" "—making people feel about a thing as you do;" and "—persuading people to do what they hadn't intended to do."

To some, salesmanship is considered a science—collected in thought, organized, and reduced to a body of principles. But to the chary sales manager, this is not so. He knows that as long as selling deals essentially with human nature, it will remain a complicated art. It is true that one may apply psychology, economics, physiology (this is possible), sociology, etc., to his studied presentation but again these college subjects are loaded with the exceptions rather than rules. In this day of "hidden persuaders," the personal and direct contact of the salesman is still the keystone to company growth. In a specialized field, it is more so in evidence.

For instances—and a definition

The Yankee Peddler had his staple items and used "pat" selling phrases to push his line. He roamed about the country playing his percentages. Today, especially in plastics, the salesman is constantly meeting up with new situations. The buyer may have had a bad experience. The prospect may be reactionary or cool towards using plastics. The material is too new to the engineer, is not yet proven. His client is more interested in entertainment. This man wants a brief presentation and hates wasted words; that man is ready to "pump" the salesman or sales engineer for all the facts he can learn. One buyer is jovial and likes jokes, another buyer just sits back and assumes a fish-like stare. Some purchasing agents want to catch you off guard, others understanding or respectful.

Where does this preliminary verbiage lead? Quite frankly, to my viewpoint on how to be successful in sales, particularly relating to my own thermoset sales experiences. First of all, my definition: A plastic salesman must be an opportunist who cannot afford to overlook a possible prospect; then to his prospect he must be able not only to demonstrate his product successfully but keep in mind that he must establish a *permanent* customer.

The role of conscience

The salesman should know that man's behavior is governed by many natural characteristics: instinct, reason, intuition, emotion, experience, imagination, reflex action, learned behavior, mass or mob rule (referring to general emotional action), and a tendency to go along with the majority. However, in the long pull, it is conscience that becomes the dominant motivation. Both buyer or salesman want to do a good job. Should a customer be sold on any other basis than fact or truth, the relationship is ephemeral. It is the action of good conscience that is the leading factor in establishing good and permanent customer relationships. The imprudent salesman or purchasing agent does not last.

Huck Finn morality applied

What does Huck Finn have to do with salesmanship? Only as far as conscience playing a part in the role of a salesman. It is known that Huck Finn's conscience dictated his actions. Within him was a constant struggle of morality. Should he follow the customs and mores which to him represented "good" or should he follow what his conscience told him to do which to him represented "evil"! When he decided that he was not going to turn in Jim, the slave, but instead strike for Jim's freedom, he knew that he was doing an immoral thing because slavery was morally accepted in

his society. To go contrary to this had to be "evil." But he reasoned "That's always the way; it don't make no difference whether you do right or wrong, a person's conscience ain't got no sense and just goes for him anyway."

So it may be in selling. A salesman wants desperately to sell his product. He should realize that some purchasing agents, the engineers, or the executives may be willing to accept the "customary" bribe, the kick back, the very lavish entertainment, the eulogy, and other artifices, but at the same time he is disturbing the conscience of his prospect. There may be temporary success in gaining the order, but the relationship can be terminated rather quickly by this same customer. Let us bear in mind that self preservation is the first law of nature and a man will instinctively protect his livelihood. It is only through good, conscientious, and qualified sales activity that a *permanent* mutuality can be established and continued.

It is true that there are cases where an engineer or purchasing agent will not allow the salesmen to compete because of a promise or "obligation" to the competition. Too, this same engineer or purchasing agent may use only one material, one molder, or one source. A situation difficult to overcome! Everything else being equal, conscience will ultimately play its part.

Avoid stereotype selling

To portray his product properly, a salesman contacting the prospects must constantly rely on most of his faculties. Again, the salesman must understand the diversity of human behavior.

There is no such thing as a common man or an average person. Man is an individual, and as complex in make-up as nature itself. Whereas, an end or purpose may be common, the means may have to vary to produce results. The salesman often goes a step further and considers "the means" of the means to the end. This implies that a salesman must have not only the tools (or means) which are his facts, but modify his discussion to suit his client. It involves a consideration of the complex nature of man. The salesman who uses stereotyped methods or means and does not consider his customer's nature will have a low percentage of successful sales. Failure to obtain the order may often be due to a negative reaction to the salesman himself. It is wise to know or analyze the nature of a purchasing agent and respect him as an individual. Good relationships are built on mutual understanding.

Timing the presentation

A well thought out presentation which can be delivered equally well in five minutes or thirty minutes is a work of art. A qualified salesman adjusts himself according to the time given him. This concept can best be demonstrated by noting the format a journalist uses when he writes a news item. Read one and notice! The first paragraph gives all the facts. Succeeding paragraphs are embellishments of the preceding facts. A presentation built in this fashion can be cut off at any time and still have included the salient points. Often the busier the prospect, the more important he is to his own company and consequently the less time he has to give. However, the more interested he is in your product, the more time he'll give you and the more important you can be to him. In this "two way street" between the buyer and the salesman, there is an approach, a presentation, an understanding, and the establishment of a *permanent* relationship.

Conclusion

I do not mean that success is possible for everyone and anyone. There are some prospects who never will be sold, others are easily sold. Let your conscience be your guide. Avoid using the same sales technique with all prospects. Be adaptable. Finally, time your sales talk so that it fits both customer and occasion.

For the author's additional viewpoints on Sales see: "Selling With The Times," PLASTICS TECHNOLOGY, January, 1961. —THE END

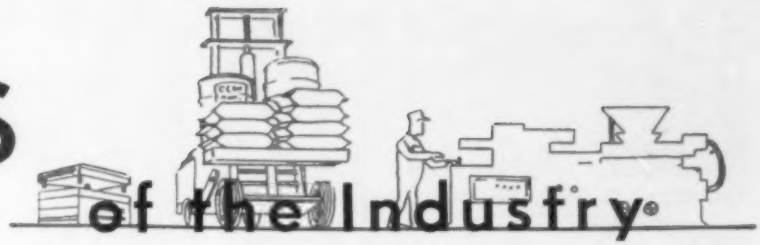
What's wrong with machine instruction manuals?
(*Con'd. from page 35*)

The circuit functions as follows: When the clamp cylinder is moving forward with little resistance, the flow of both pumps is combined, the large pump flowing through check valve A. When the cylinder clamps, resistance is met and oil pressure builds up until it reaches the setting of the unloading valve (3) (in this instance 400 psi.). This pilots the unloading valve, by-passing the oil from the large volume pump (2) to the tank. Oil from the small pump (1) cannot get into this line and dump into the tank because of check valve A. The small-volume high pressure pump (1) continues to build up pressure in the clamp circuit to the setting of the high pressure relief valve (HPRV). Pressure is maintained at that point.

The booster circuit (if any) and the method of providing oil to the injection cylinder might follow from here. Commonly expected breakdowns should be listed and a point-by-point check procedure established which the maintenance man can follow and determine the trouble source. This has been ignored completely by many manufacturers and covered inadequately by others. This is the key portion of the manual towards which the previous material has been pointed.

It goes without saying that information such as die set-up procedure, pressure adjustment, temperature adjustment, start up, operating procedure, etc. should be (and usually is) included. The molder can exert considerable influence when buying a machine. It is to the advantage of the machine manufacturer to have his machine utilized at its maximum efficiency. This increases the possibility of reorders and recommendations to other molders. A good instruction manual is a key tool in achieving this end. —THE END

NEWS of the Industry



changes in ownership, new companies

Plastics Corporation of America, Inc., Minneapolis, Minn., has acquired United Fabricators and Electronics, Inc., Stillwater, Minn., and a subsidiary, St. Croix Plastics Corp., Dresser, Wis., as the second operating division. United Fabricators specializes in the design and precision molding of parts from nylon, Delrin, etc., especially plastic gears.

Borg-Warner Corp., Chicago, Ill., has obtained a controlling interest in Fibermold Corp., Gardena, Calif., fabricator of thermosetting plastic products, for its Ingersoll-Humphryes Div. The latter is a producer of bathroom and kitchen plumbingware. Fibermold becomes a subsidiary of Borg-Warner.

Permacel Div., Johnson & Johnson, New Brunswick, N.J., has sold its epoxy electrical insulation potting and encapsulation product line to Hysol Corp., Olean, N.Y.

Trophy Industries, Inc., Los Angeles, Calif., is a newly established West Coast firm specializing in plastic swimming pools, air mattresses, inflatable pool toys, floating games, etc., as well as heat sealed plastic and vinyl quilting. Louis Urbach a producer of plastic products for more than 15 years in the New York area is president.

Amoco Chemicals Corp., Chicago, Ill., has purchased a substantial minority interest in Furukawa Chemical Industries, Ltd., Tokyo, Japan. which manufactures among other things, high density polyethylene and copolymers under license from Standard Oil Co. (Indiana).

Powertron Ultrasonics Corp. has opened a West Coast subsidiary, Powertron Pacific Corp., in Los Angeles.

D-M-E Corp., until recently Detroit Mold Engineering, has been acquired by Voi-Shan Industries, Inc., Los Angeles. D-M-E will continue to operate all its facilities as a VSI subsidiary, with no change in sales policy, management, or personnel.

Nalge Co., Inc., has purchased American Agile Corp., which it will operate as a subsidiary, American Agile Co. No other changes are anticipated; however, the combined organization will have greatly expanded facilities in the plastics field.

Burton Mfg. Co., Northridge, Calif., has acquired Technical Plastics, Inc., of San Mateo, which it will operate as a division.

Houdry Process Corp., Philadelphia, and Compagnia Internazionale Generale Industriale-Malatesta, Cassino, Italy, have formed an equally-owned company, Montecassino, S.p.A., to manufacture and sell polyurethane foam and foam products.

Spencer Chemical Co. has acquired all the stock of Wrapture, Inc., a supplier of flexible packaging materials located in Flushing, N. Y. This is the third such acquisition this year, and all are now operating as wholly-owned subsidiaries.

new plants, labs & additions

E. I. du Pont de Nemours & Co., Inc., has announced that its new multi-million pound plant for "Alathon" low density polyethylene at Victoria, Tex., is now in full commercial production. Constructed as a part of a major expansion program of the company's Polyolefins Div., the Victoria unit is a second manufacturing site for DuPont polyethylene and with another new unit, currently under construction, brings capacity in both high- and low-pressure varieties to about 400 million pounds annually. DuPont has also announced plans to double the capacity of its polyethylene film plant in Richmond, Va. to 60 million pounds a year of packaging film. These new facilities are expected to start production about the middle of 1962.

Humble Oil & Refining Co. is expanding its polyolefin plant at Baytown, Tex. by approximately 50% from an initial rated capacity of 40 million pounds per year. Enjay Chemical Co., a division of Humble which markets the Escon polypropylene plastic produced at Baytown, says this phase of the expansion program will be completed by November and that plans have been approved for a further expansion to double the plant's original capacity by the second half of 1962, and that the plant is capable of producing other polyolefins, currently in various stages of development.

Reynolds Metals Company's plastics division has announced a program to expand the production of its Grottoes, Va. plant for the production of "Reynolon" oriented polyvinyl chloride film to a level about triple that of a year ago. A previous expansion in this plant's capacity, launched in May 1960, is nearly completed and the present expansion is scheduled for completion by the end of this year.

Powertron Ultrasonics Corp., with plant facilities at Westbury and Garden City, N.Y., and Huntsville, Ala., has announced the opening of its new West Coast susbidiary, Powertron Pacific Corp., at a new 3,000 square foot location in Los Angeles, Calif.

Raritan Plastics Corp., formerly of Paterson, N.J., custom extruders, has expanded its facilities and moved into a new plant of approximately 25,000 square feet in Oakland, N.J.

PLASTICS TECHNOLOGY
EXPLORING FABRICATION TECHNIQUES

By L. J. ZUKOR, *ENGINEERING EDITOR*

Extruding rigid bookbinders.

Are you custom molders making the money you feel you should? If not, you might take a page from Ken Crawford's notebook—quite literally, since he combined his knowledge of bookbinding and plastics to produce a one piece, semi-rigid, loose leaf binder self-hinged at the folds. His efforts in designing this type binder have "paid-off" in creating a demand for his particular product and services.

Crawford Industries' process starts with the extrusion of sheet, and innovations start immediately with the extrusion die. This is their own design, with a true end-feed and a slightly tapered bore for balanced flow to a full length dam. The die has a fixed lip plus an adjustable lip, easily sprung to regulate web thickness.

After leaving the die, the extruded web passes between two cooling rolls, which double as embossing rolls to save time and space. A levered mechanism adjusts the nip of these rolls. From the embossing rolls, the web passes under a third cooling roll and thence over an idler roll conveyor where an air blast completes the cooling. Rubber surfaced draw-down rolls next, in turn, feed the hardened plastic web to a synchronized pneumatically-operated shear. A rotary steel rule die set-up or other continuous cutting device could readily substitute the shear mechanism.

A cutter blade set in a holder just ahead of the draw-down rolls divides the web in half. Rough cut pieces fall in orderly stacks from which they are removed and placed into a motor-driven guillotine cutter where sheets are trimmed to size. This and a filleting cut to round the corners of the trimmed sheet are secondary operations that can be eliminated when a sheeting line is completely automated. The extent of automation also depends on the production quantities required for any single book size. Secondary cutting operations allow for many size books to be run from the same web as long as material, color, and thickness are alike.

The job I saw run was the cover for a Goodrich-Gulf Chemicals brochure. Their resin, Ameripol No. 34, a high molecular weight, 0.06 M.I., 0.95 density, compounded chalk white polyethylene was used. This cover has a fine pebble finish imparted to it by the sand blasted embossing rolls which gives a dull luster rather than the high gloss possible with polished chrome rolls. Other materals used for book covers at Crawford Industries (with varying degrees of success) are; standard and impact polypropylenes, cellulosics, acrylics, impact polystyrenes, and ABS materials.

Finishing operations used to complete the product include flame treatment of the surfaces of the trimmed blanks prior to printing or silk screening (this operation is necessary mainly for polyethylene), embossing the hinge section, and rounding the back to receive the snap ring mechanism. Rivet holes for attaching the

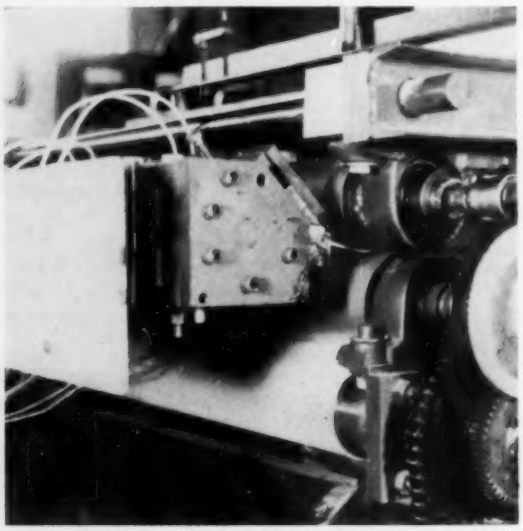


Photo courtesy: Crawford Industries, Inc., Robert Olsen, photographer.

Embossing and cooling roll arrangement.

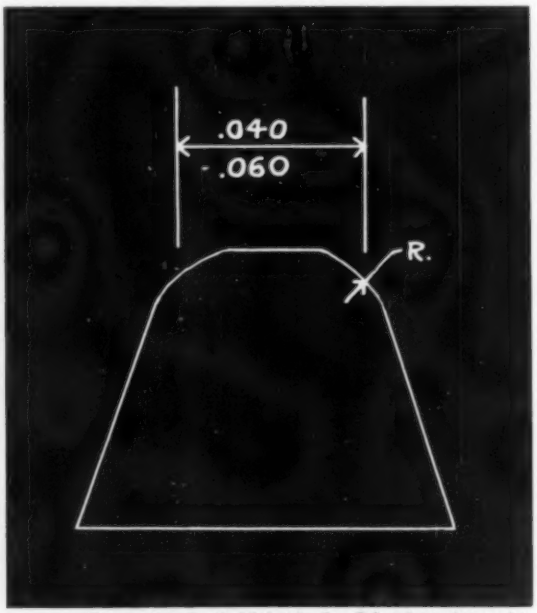


Photo courtesy: Crawford Industries, Inc., Robert Olsen, photographer.

Cross section diagram of embossing bar.

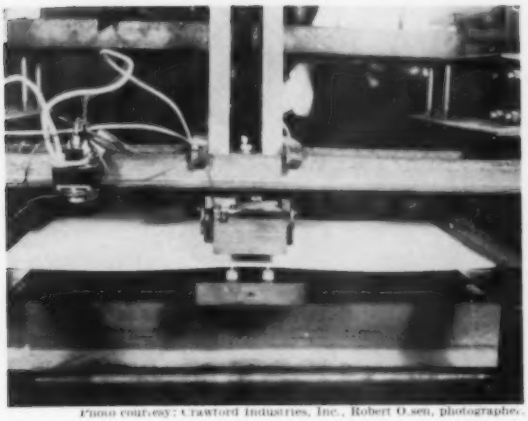


Photo courtesy: Crawford Industries, Inc., Robert Olsen, photographer.

Front view of hinge embossing machine.

ring mechanism are punched prior to, during, or after the embossing operation, as dictated by the tooling set-up for any given size book.

Polypropylene was the first material tried when the book design was conceived, because of its widely publicized hinging feature. However, it had certain limitations for book cover applications. Standard polypropylene has limited impact resistance, while the rubber modified high impact material shows strain discoloration (a whitening in colored stock) from the impression of the rings on the closed cover. Although the hinge in polyethylene can not compete with polypropylene in the number of stress reversal cycles, it will withstand more than 30,000 which is adequate for a book.

The hot stamping machine used for embossing the hinge section of the book was designed and built by Crawford Industries. Basically, it is a toggle type unit with built-in adjustments for centering the trimmed sheet and changing the width of the book backbone. The stroke of the air cylinder is also adjustable which, in turn, fixes the distance between the heated platen and the truncated (in cross section) cone-shaped embossing bars. This fixed distance determines the thickness of material left in the plastic hinge for flexing. In general, this thickness should not be less than 0.005-in. or more than 0.015-in. for a proper fold. The truncated top of the cone should have a flat dimension of 0.040-0.060-in. with the edges broken to 0.010-in. radius minimum. These dimensions will give satisfactory hinges in most of the thermoplastic materials. The heated flat platen is thermostatically controlled and was set at 250 ± 5°F. for the 0.060-0.065-in. thick Ameripol book. Removal of the formed sheet from the hot stamper, on cooling, has a flat backbone. But, if the sheet is removed while still hot and placed in a curved cooling mold, it will harden with its back curved to a given radius.

The sheeting run using high density polyethylene was made on a 2½-inch NRM extruder equipped with four heat zones. Zone 1, closest to the feed hopper, was set at 410° F. as were zones 2 and 3. Zone 4, near the die, was set at 470° F. The extruding die has three heat zones, each set at about 470° F. These heats agree with the recommendations of Goodrich-Gulf for an extrusion temperature of 450° F.

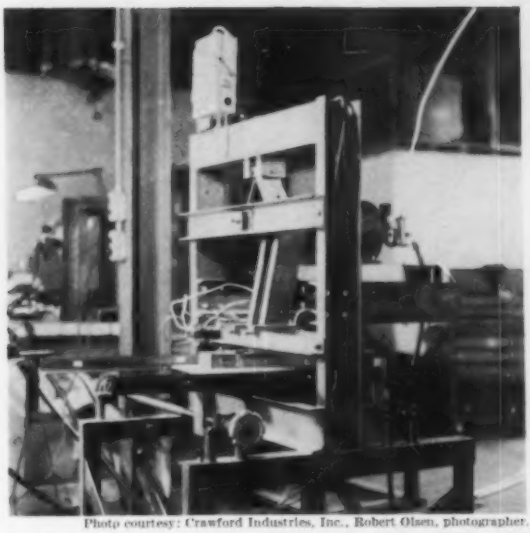


Photo courtesy: Crawford Industries, Inc., Robert Olsen, photographer.

Side view of embossing machine showing toggle arrangement.

Heated water was used to maintain the temperature of the polishing or embossing rolls at 190° F. This was lower than the recommended temperature (250° F steam), but it had no ill effect on the material.

Using magnets in injection molding

Magnetic materials have been successfully used t hold floating steel inserts in injection molded parts Armand Marcucilli, president of Grace Plastics Corp., recently showed me some of his molds for reinforced polyethylene flower stems. These molds use alnico V magnetic inserts to hold soft steel wire reinforcement in the vertically positioned injection mold. The molten plastic, under hydraulic pressure, surrounds the insert and centers it in the cavity. At injection molding temperatures (350-500°F.), alnico magnets retain 90% of their magnetic properties over long periods of use.

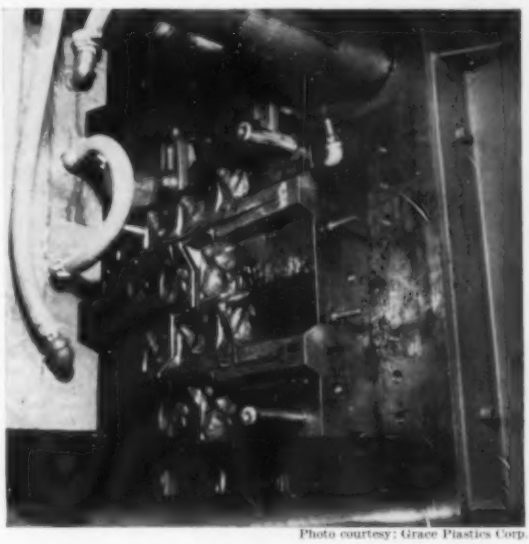
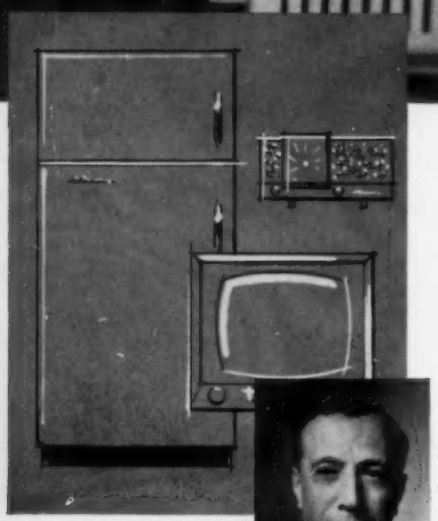


Photo courtesy: Grace Plastics Corp.

Flower stem mold with magnetic wire retainers.



"Maybe this 132 years of plastics know-how can help solve <u>your</u> appliance molding problem," says Joe Foster.

For more information check Readers' Service Card

L. to R.: Jack Iacoboni, Chief of Technical Service; Tommy Eyles, Chief Engineer; John LaBelle, Mgr. of Customer Service and Dr. Ray Hartigan, Dir. of Research, discuss solutions to an appliance manufacturer's molding problem.

That's the total amount of plastics know-how represented by the veteran production-design-research team you see in the above photograph.

These men, who have helped Foster Grant make major contributions to plastics progress over the years, are here solving molding problems in the production of home appliances. Maybe their recent successes with Fosta Tuf-Flex high-impact polystyrene in appliance mold design and production will suggest ways our resins—and our services—may be of value to *you*.

For instance—Fosta Tuf-Flex high-impact polystyrene is being used for refrigerator inner-door liners and freezer doors.

Other current appliance applications for Fosta Tuf-Flex include refrigerator crisper trays and light-bulb shields, intricately die-cast radio cabinets, ice-crusher parts and electric can-opener housings.

Why not put this combined 132 years of practical molding know-how to work on your product design, molding and merchandising problems? Call or write us today. Foster Grant Co., Inc., Leominster, Mass., KEystone 4-6511.

FG

Your Partner in Plastics Progress **FOSTER GRANT**
Leominster, Mass.

Fostarene®, Fosta Tuf-Flex® and Fosta® Nylon resins are also distributed by H. Muehlstein & Co., Inc., New York, N.Y.

(Continued from page 45)

new plants, labs & additions

Oronite Division, California Chemical Co., plans to build an East Coast plant to manufacture phthalic anhydride. The site is Perth Amboy, N. J. and the annual capacity is estimated at 30-million pounds.

California Chemical's Oronite Division is moving its Chicago sales office to 101 South Washington Ave., Parke Ridge, Ill.

Ankurt Associates, Inc., mold makers, has expanded its facilities in New York City. New sales manager is James S. Hanofee.

Raritan Plastics Corp. has opened its new plant in Oakland, N. J. Its available footage, 25,000 square feet, represents a 50% increase.

Celanese Plastics Co. will expand production of blow molded containers in the Midwest and on the East Coast. A new plant will be built in Batavia, Ill., and a plant has been purchased in New Castle, Del. The latter will replace the Trenton, N. J., operation.

R. D. Wood Co. has moved its general offices from Philadelphia to Florence, N. J. The firm manufactures hydraulic presses.

National Starch & Chemical Corp. has announced plans to build a $4-million vinyl acetate monomer plant with an annual capacity of 45-million pounds. One of two Texas sites currently under consideration will be chosen, and should be in operation in the fall of 1962.

Mobay Chemical Co. plans to construct additional multi-purpose plant facilities for the manufacture of a range of organic isocyanates. They will expand capacity by several hundred tons per month.

Polycast Corp., Stamford, Conn., is completing a plant expansion program which is expected to triple its production, as well as provide expanded laboratory facilities.

Abbott Plastic Machine Corp. has moved its main plant from Clark St., to 2718-26 Broadway in Chicago. The firm manufactures skin packaging equipment, pressure forming, and die cutting.

Taylorcraft, Inc., has begun the fabrication of fiber glass-reinforced plastics in Connellsville, Pa. The firm produced and marketed the first plastic plane.

Tedlar is the new name for Teslar—the polyvinyl fluoride film produced by E. I. du Pont de Nemours & Co.

Raritan Plastics Corp. has opened a 20,000 square foot plant in Oakland, N. J. The firm specializes in custom extrusion.

Rogers Corp. has begun an addition to its Manchester, Conn., plant which will double its capacity for producing diallyl phthalate molding compounds.

Abbott Plastic Machine Corp., manufacturers of skin packaging equipment, have moved their main plant and executive offices from 7124 N. Clark St. to new facilities which include 14,000 square feet of shop area, 1,000 square feet of office space and a large showroom at 2718-26 Broadway, Chicago, Ill.

Argo Plastics & Chemicals, Ltd. has moved into a new plant in West Toronto, Ont., Can. Argo handles special colorants, resins and molding materials and offers a complete compounding and color service. Donald P. Clarke has been appointed vice president of the Plastics Div. of Argo.

Clark-Schwebel Fiber Glass Corp. has started the production of glass fabrics at its new 163,000 square foot plant designed and built exclusively for glass fabrics at Anderson, S.C. The company will produce a complete range of fiber glass fabrics and woven glass roving for high and low pressure reinforced plastics applications.

Canadian Industries, Ltd., has opened a Vulcanel BN plant in Hamilton, Ont.

Martin Plastics, Inc., is moving into a new building at 351 Oliver St., Newark. The old address was in Linden, N. J.

Amphenol Eastern Connecter Division, Amphenol-Borg Electronics Corp., has moved into its new plant in Fairlawn, N. J.

AviSun Corp. opens its 100-million pound polypropylene plant in New Castle, Del., on September 31. This makes AviSun the world's largest polypropylene producer.

E. I. du Pont de Nemours & Co. plans to erect a Delrin oil-field pipe plant in Tulsa. Scheduled for completion next summer, the unit will have a capacity of 5-million pounds annually.

agents, distributors & agreements

Landers-Segal Color Co., Brooklyn, N. Y., has appointed A. L. Webb & Sons its sales representative in Maryland, Virginia, and the District of Columbia.

Tufline Plastics, Inc., Milwaukee, has been organized to distribute products made by Sunlite Plastics. In July, we reported this in a way so that it could be construed that Sunlite was ceasing plastics production. We are very sorry for any confusion incurred.

Eastman Chemical Products, Inc., Kingsport, Tenn., has signed a licensing agreement for the extrusion and distribution of Uvex sheet with Flex-O-Glass, Inc., Chicago, Ill. Uvex sheet is processed from special formulations of Eastman's Tenite butyrate designed for outdoor use.

L. V. Lomas Chemical Co., Ltd., Downsview, Ont., Can., has been named by the J. M. Huber Corp., New York, N.Y., as exclusive distributor in the Provinces of Quebec and Ontario for Huber's specialty kaolin clays and Zeolex synthetic silica pigments to the paint, varnish, printing ink, plastics and allied processing industries.

Names in the News

Robert P. Conger has been appointed manager of research for Congoleum-Nairn, Inc., manufacturer of smooth surface floor and wall coverings. Dr. Conger comes from U. S. Rubber Co., where he was a research chemist.

William F. Kimmer, former staff assistant to the production manager at McCulloch Corp., has been appointed superintendent for machine manufacturing at G. T. Schjeldahl Co.

P. Edward Rycyk has been elected president of Consolidated Bases, Inc., a company recently organized to manufacture molded bases for plastic and die casting molds.

George A. Littlefield has been named general manager of the Panelyte division of St. Regis Paper Co. Previously on the staff of the executive vice president in charge of operations, he will be responsible for both sales and manufacturing operations of the division.

John K. Whittaker

John K. Whittaker has been named president of Modiglass Fibers, Inc., subsidiary of Reichhold Chemicals, Inc. He was executive vice president of Modiglass, and will continue to be located at its main plant and office in Bremen, O.

W. H. Salzenberg, general manager of the polychemicals department of E. I. du Pont de Nemours & Co., and **T. T. Miller,** president of W. R. Grace & Co., polymer chemicals division, have been named chairman and vice chairman of the plastics committee, Manufacturing Chemists' Association.

W. B. Sander, manager of the Fresno, Calif., plant of Dobeckmun Co., has been appointed to the new post of west coast production manager. He will be responsible for production at the Berkeley plant, and for the polyethylene extruding operations in Fresno and Hawaii.

R. W. Martin, former head of the thermoplastics department at Shell Development Co.'s Emeryville Research Center, has been moved up to director of plastics and resins research and development.

Walter F. Oelman

Russell C. Weigel

The Society of the Plastics Industry, Inc., has announced the election of new officers and directors for the year June 1961 through May 1962. They are: director and chairman of the board—**Russell C. Weigel,** assistant general manager, polychemicals dept., E. I. du Pont de Nemours & Co., Inc.; director and president —**Walter F. Oelman,** president, Standard Molding Corp., Dayton, O.; director and vice president — **T. T. Miller,** president, polymer chemicals div., W. R. Grace & Co., director and secretary-treasurer — **Harry M. Jenkins,** general manager, General American Transportation Co., Chicago, Ill.

In addition, three sectional directors, 13 industry division and committee directors, and nine directors at large were elected.

Bernard W. Brooks has been elected president and a member of the board of Sheffield Plastics, Inc. He has been engaged in production, sales service, engineering, and research with the firm since 1957. At the same time, the company announced formation of a division of research and development with **John B. Orr** as its director. Mr. Orr joined Sheffield as treasurer in 1953, and assumed the presidency in 1957.

Frederick A. Krone has been appointed technical and marketing director of polyolefin operations by Foster Grant Co., Inc. He was manager of market research and development, polymer chemicals division, W. R. Grace & Co.

William C. Mertz

William C. Mertz has been promoted to the position of director of polyolefin film development by Dobeckmun Co. A senior research chemist for the past three years, he will now be located at Dobeckmun's Findlay, O., plant.

Warren Weinberg, president of J-E Plastics Mfg. Corp., has assumed the responsibilities of chief executive officer of the company upon the resignation of **Herbert Magnes,** chairman of the board. Mr. Magnes will remain as an advisor and consultant. Mr. Weinberg, with the company since 1951, had been executive vice president and general manager before his election as president in March.

Coleman F. Hogan has been elected president of Davidson Rubber Co. A director for the past six years, he succeeds **Virginia P. Dee,** who will continue to serve as treasurer.

Harold C. Steadman

Harold C. Steadman is now a director of Richardson Co., laminators and molders of plastic products. Shortly after joining the company as general manager of the plastics division in 1958, he was elected a vice president.

Howard Shannon

Howard Shannon has been elected vice president of Amerace Corp. He is associated with four of the Amerace divisions; as president of American Hard Rubber Co. and Supplex Co., and operational supervisor of Ace Bowling Co. and Ace Comb Co. He has been with Amerace since 1940, when he joined American Hard Rubber as a chemist.

OBITUARY

Ruth Anna Jago, president of Thwing-Albert Instrument Co., died on Sunday, May 28, after a brief illness. She was 61.

Miss Jago had been with the company for 43 years. Elected secretary in 1938, she became president in 1957. She was active in ASTM, Scientific Apparatus Makers' Association, and TAPPI.

Edward J. Albert, chairman of the board since 1957, has assumed the duties of the presidency.

New Materials

For more information check Readers' Service Card (p. 73)

Nylon 6 molding resins

Spencer Chemical Co. has developed two new nylon 6 resins, Spencer nylon 401A and 605A, which are said to reduce injection molding machine cycle times as much as 40% in applications ranging from miniature parts produced in multiple-cavity molds to single-cavity molds taking up to three pounds per shot.

The new materials are said to have increased flow properties over similar materials and to require lower ram pressures and heater settings which permit the reduction of sinks and voids in molding thick-section parts and provide for quick and adequate filling of intricate and thin-walled molds.

401A has shown the fastest cycle times and is generally recommended for intricate and hard-to-fill molds; 605A has a higher impact strength and is recommended for the production of massive and load-bearing parts, such as gears and housings. Increased processing speed causes no decrease in physical property levels, according to Spencer.

Readers' Service Item 1

Low viscosity plasticizers

Two more low viscosity, low volatility plasticizers, Admex 752 and 755, have been added to its line by Archer-Daniels-Midland Co. to help vinyl compounds for automotive applications meet recently revised requirements.

Admex 752 has improved low temperature properties coupled with low volatility and excellent resistance to fogging, with better resistance to soap and mineral oil extraction than DOP. Admex 755 should prove useful in applications where low viscosity and low volatility are needed in combination with very good fog and extraction resistance and fair low temperature characteristics. Some properties of these two plasticizers follow:

	Admex 752	Admex 755
Acid value	0.5	0.7
Color (Gardner '53)	1	1+
Viscosity, 25°C., stokes	1.4	4.5
Lbs. per gal.	7.85	8.37
Refractive index	1.4614	1.4681
Flash point, °F.	545	495
Fire point, °F.	585	615
Pour point, °F.	+10	+30

In vinyl compounds in which 50 phr. of these plasticizers were used, Shore A hardness was 82 and 88, tensile strength 2507 and 2817 psi., 100% modulus, 1180 and 1600 psi., Clash-Berg (Tf = 135,000) −30.5° and −10.8°C., % loss on gasoline extraction, 21.3 and 7.6, and carbon volatility, % loss, 0.5 for both plasticizers.

Readers' Service Item 2

Low cost, phenolic

Rogers Corp. has developed a low-cost, medium-impact, two-step, phenolic-cellulose molding compound featuring excellent preforming and molding characteristics. Designated RX 522, it can be compression, transfer, or plunger molded with ease, to a lustrous, black finish and is recommended for use in all types of automatic equipment.

The compound has a bulk factor of 2.8 to 1. Molded properties include an impact strength of 0.4 (min.) ft. lbs./in. of notch, flexural strength of 11,000 (min.) psi., tensile strength of 8,000 (min.) psi., water absorption rate of 0.5%, heat distortion point of 320°F. (min.), and short time dielectric strength of 300 (min.) vpm.

Readers' Service Item 3

Black extrusion PE resin

Alathon BK 3425 black polyethylene resin for extrusion coating has been introduced by the polyolefins division of Du Pont Co. The resin has a base density of 0.923 and a melt index of 3.7. Containing 2.5% of carbon black, it may be run at temperatures in excess of 625°F. and at speeds as high as 1000 ft./min. down to very thin coatings with excellent adhesion.

Alathon BK 3425 is recommended for use in paper-polyethylene combinations in the construction and agricultural fields where durability, moisture barrier properties, and weatherability are prime requirements.

Readers' Service Item 4

PE resin for blown film

Dylan 2037, a polyethylene resin for extrusion into very clear glossy film by the blown tubing process, is available from Koppers Co., Inc., plastics division. The film possesses a high degree of strength, may be extruded at high speeds between 325 and 425°F., is easily colored, and has printability as well as good heat-sealing properties, according to the supplier.

Film made from this resin can be classified as Class 2 (high clarity), Type I (normal impact), Grade 2 (medium slip) material, according to Commercial Standard for Polyethylene Film, CS-227-59. Both lower and higher slip levels of Dylan 2037 can be provided to suit the individual customer's requirements.

The film may be converted into bags or overwrap for packaging textiles, toys, custom jewelry, candy, baked goods, and paper goods.

Readers' Service Item 5

Electrical grade copper-clad epoxy laminate

A copper-clad epoxy resin-paper base laminate (Micarta Grade 65M24) for printed circuit and other electronic applications requiring high strength and consistent electrical properties over a wide range of humidity levels has been announced by Westinghouse Electric Corp., Micarta Div. The new material is said to withstand a wider range of humidity than do superior grades of phenolic resin-paper base laminates. It is less expensive than NEMA G-10 and G-11 glass base-epoxy resin laminates. Micarta Grade 65M24 is classed as a nonburning material and has good punchability at room temperature. It is said to be superior to standard cold punch phenolic-paper base laminates in flexural strength (24,000 psi with grain), bond strength (9 pounds average), and solder resistance (20 secs. to solder at 500°F.).

Electrical properties include a dissipation factor of 0.034 at one megacycle; dielectric constant of 4.5 at one megacycle (after 24 hr. immersion in H_2O at 50°C.); insulation resistance of 100,000 megohms; volume resistivity of 1,000,000 megohms-cm.; and surface resistance of 1000 megohms (after 96 hr. conditioning at 34°C. and 90% relative humidity). The material is available in sheets 36 by 36 inches or 36 by 72 inches and in thicknesses from 1/32 to 1/4 of an inch.

Readers' Service Item 6

Nontoxic polypropylenes

Three polypropylene polymers, two of them meeting FDA regulations for food and drug applications, have been introduced by Avisun Corp.

The two polymers suitable for use in contact with food or drugs are 4011 for extrusion applications, and 4014 for injection molding uses. Suggested applications are in extruded squeeze tube packages; injection molded containers for dairy products and hard foods; vacuum formed containers for disposable blister packages; boilable food packs; and blow molded containers for baby food.

In addition to these polymers, a high flow injection molding polymer, 1016, has been announced. Grade 1016, with properties comparable with Avisun's general purpose injection molding polymer 1014, is a well stabilized resin especially designed for high speed multiple cavity molding situations where close shrinkage and warpage control of the molded part is desired. Applications for 1016 include molded parts with deep draw and thick sections, such as knife handles.

Readers' Service Item 7

Curing agent for solventless coating systems

An improved curing agent for solventless coating systems is available from Ciba Products Corp. Araldite DP-121A in combination with low viscosity epoxy resins (e.g., Araldite 502) produces coating systems that can be applied in single-coat, dry-film thicknesses of 5-10 mils. DP-121A epoxy systems have longer pot lives than previous solventless epoxy systems and since no solvents are present, fire hazards are minimized.

Flow control agents are unnecessary with DP-121A and systems using this new curing agent exhibit improved levelling and gloss, eliminating pigment flocculation problems. Finishes cure at room temperature to hard, tough, flexible films, high in gloss and with good chemical resistance.

Readers' Service Item 8

Three polypropylene resins

Three polypropylene resins for injection molding, two of which meet the requirements of the Food and Drug Administration, have been announced by Spencer Chemical Co. Poly-Pro 9 and Poly-Pro 12 are general purpose materials satisfactory for use in contact with food. The former has a melt index of 3.5 and is said to give excellent clarity in thin section applications; the latter has a melt index of 5.5 and is designed for fast molding cycles.

Poly-Pro 10 has demonstrated about 25% better heat resistance in laboratory tests than other polypropylenes stabilized against heat. It will withstand steam sterilization and is said to perform satisfactorily at continuous elevated temperatures as high as 250°F. It is recommended for home laundry and dishwasher components, hospitalware, television backs, slide projectors, and other applications where extended high temperature service is encountered.

Readers' Service Item 9

Four polymeric plasticizers

Emery Industries, Inc., has developed four new polymeric plasticizers which, with the older Plastolein 9720, are expected to reach a large segment of the vinyl industry. They are reported to be among the most economical of the polymerics.

Plastolein 9722, an improved version of 9720, provides increased soapy water and migration resistance, better compatibility and outdoor aging, and reduced losses to extraction media. Recommended for furniture and automotive coated fabrics, baby wear film, and other applications requiring permanence, it should not be used where low temperature or viscosity characteristics are prime requisites. Low cost 9730, designed for tapes, shoes, coated fabrics, etc., is noted for migration and extraction properties.

The third material, 9750, is a general purpose, medium molecular weight, semi-resinous plasticizer. Outstanding in its resistance to hydrolysis and outdoor aging, it is said to combine an excellent balance of performance properties with easy processing.

According to Emery, Plastolein 9765 contributes superior migration and extraction properties, low odor level, excellent compatibility and resistance to humidity aging, and outstanding resistance to soapy water and alkali to PVC compounds. It can be used in nearly all vinyl areas associated with polymeric plasticizers.

Following is a tabulation of typical physical properties of these Plastolein plasticizers. Tables comparing performance in vinyl films are also available.

	9722	9730	9750	9765
Molecular weight, theoretical	1,000	1,100	2,200	3,500
Acidity (as % acetic)	0.53	0.53	0.53	0.53
Flash point, ° F.	510	510	535	530
Fire point, ° F.	565	560	600	595
Pour point, ° F.	30	50	37	40
Solidification point, ° F.	25	45	32	35
Viscosity, centistokes at 100° F.	411	1,100	1,180	3,100
At 210° F.	34.9	52.4	79	157
Refractive index at 25° C.	1.4686	1.4826	1.4766	1.4784
Specific gravity	1.048	1.064	1.061	1.070
Pounds per gallon, 25° C.	9.20	8.86	8.84	8.93

Specifications for acid value, hydroxyl value, and Gardner color are the same for all four plasticizers. Maximum acid value is 3 and hydroxyl value, 20. Both are calculated from mg. KOH/g. Maximum Gardner color is 7. At 5 mm. Hg pressure, none of the plasticizers will boil.

Readers' Service Item 10

Improved fiberglass roving

A Fiberglas roving which provides 25% to 30% faster wet-out than competitive woven glass roving, better drape and conformity to mold contours, and improved laminate clarity, has been developed by Owens-Corning Fiberglas Corp. Faster wet-out reduces production time, thus reducing costs.

Tests conducted by Owens-Corning showed that laminates containing the new roving possess 10% to 15% greater clarity than laminates containing competitive glass roving.

Readers' Service Item 11

New Linear Polyethylenes

A series of eight linear polyethylene resins, high density R600, R800 and R810 for injection molding and extrusion; high density R211 and R401 for blow molding; and general purpose high density R200, R210 and R300 for blow molding and extrusion, have been introduced by the Dow Chemical Co.

R600 is recommended for applications which require moldability and toughness, such as automotive parts, marine battery containers, toys and appliance housings. R800 is said to be the best choice when mold fill is a problem, rigidity is desirable, warpage must be held to a minimum and impact strength or extreme toughness is not a prime requisite as in large housewares, tote boxes, etc. R800 is also recommended for film overwrap and tape backing. R810 is a polyolefin copolymer for use where good load bearing properties over an extended time period, improved low temperature properties and excellent moldability are required. Large riding toys, housewares and refrigerator components, and parts containing molded-in inserts are probable applications.

R211 is a copolymer with outstanding resistance to stress cracking and with good rigidity and, as such, is said to be suitable for such applications as detergent bottles. R401 is a homopolymer with excellent rigidity and impact strength and is recommended for bleach bottles, where superior modulus and impact strength are needed but where stress cracking is not of major importance.

R200 and R300 are homopolymers with excellent rigidity and impact strength and are recommended for rigid containers, nursing bottles, industrial parts, and for fabrication into sheet and monofilaments. R210 is a copolymer with excellent stress crack resistance and good impact resistance for applications where these properties are required as well as for creep rupture resistant monofilaments.

Readers' Service Item 12

Urethane foam potting material

A new potting material made with rigid urethane foam and especially suitable for potting electrical components is available from Freeman Chemical Corp. It is prepared by either batch or mechanical mixing of 100 pbw of Freeman's Chempol 30-1322 resin and 118 pbw of Chempol 30-1426 resin which is then poured into the void to be potted and allowed to foam and cure. Most foamed parts can be cured at room temperature but in some cases it may be desirable to cure in an oven at 150°F. for about one-half hour after foaming is complete.

The potted foam has a density of about 10 to 12 lbs./cu. ft., about six to seven times lighter than conventional potting compounds and thus its cost is appreciably less. Rigid, it has excellent dimensional stability at both low and elevated temperatures, appears to be unaffected by thermal shock cycles from 200° to —67°F., and is not cracked or distorted by immersion in liquid nitrogen. Heat distortion temperature is above 200°F. Other properties include a K factor of 0.25, tensile strength of 405 psi., shear strength of 103 psi., flexural strength of 128 psi., compressive strength at yield point of 375 psi., and a 6% deflection at yield.

Readers' Service Item 13

(Continued on page 56)

New from Emery Research

4 New Polymerics

Emery research has achieved a significant breakthrough in the field of polymeric plasticizers. Four new polymerics have been introduced to complement Plastolein 9720, the industry's largest selling polymeric. Together, they now give you a single source for a wide range of your plasticizer needs. Although Plastolein 9720 will continue to be the choice in uses demanding its ease of processing and low viscosity, the four new plasticizers meet other needs:

Plastolein 9722: An improved version of Plastolein 9720 in humidity and outdoor aging, compatability, extraction and migration—at the same low cost. (Formerly Emery 3282-D)

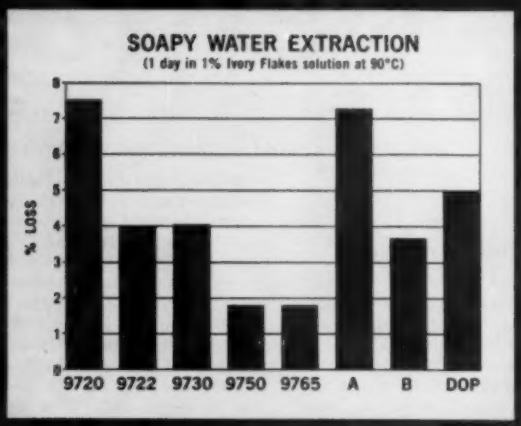
Plastolein 9730: Now, the lowest cost polymeric plasticizer featuring low migration properties, excellent outdoor stability, and good soapy water resistance. (Formerly Emery 3311-D)

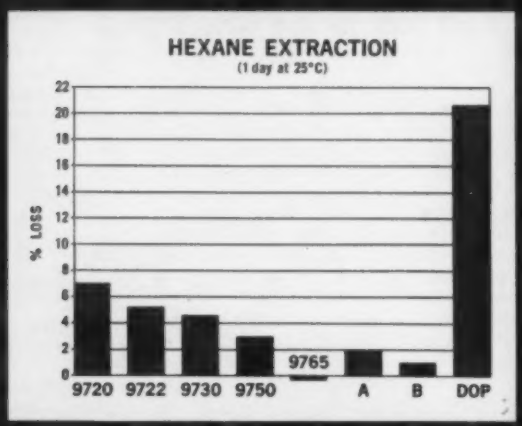
Plastolein 9750: A good, general-purpose, medium molecular weight polymeric at low cost, with excellent soapy water extraction and outdoor stability. (Formerly Emery 3313-D)

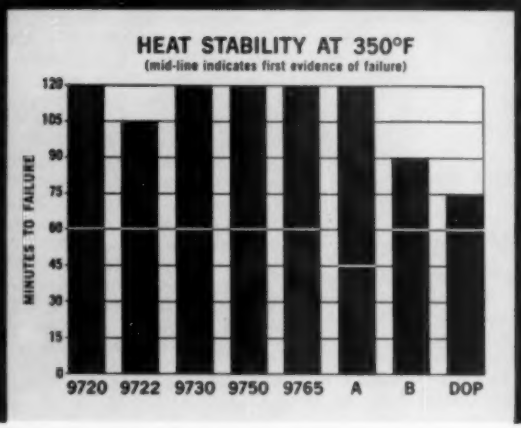
Plastolein 9765: The medium molecular weight polymeric plasticizer offering the best all-around permanence. Its cost is low, humidity aging outstanding, and extraction resistance tops. Special deodorized grade available. (Formerly Emery 3314-D)

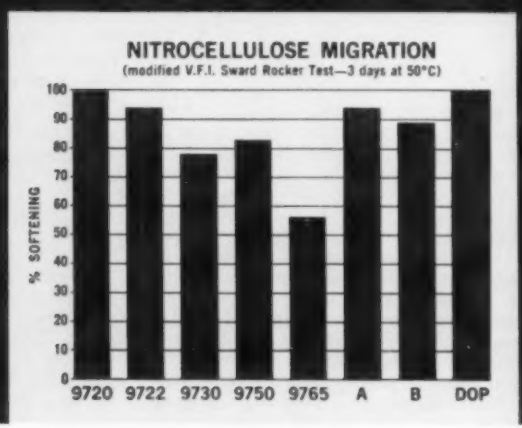
Extensive aging tests have been conducted by the South Florida Test Service. The Emery polymerics were compared with two leading competitive plasticizers and with DOP. Results show outstanding superiority of the Plastolein polymerics. Full information on the new Plastolein Polymeric Plasticizers including reproductions of test samples is available in Technical Bulletin 424. Write Dept. Q-8.

Check Plastolein Polymeric performance on eight






HEAT STABILITY AT 350°F
(mid-line indicates first evidence of failure)
MINUTES TO FAILURE
0 15 30 45 60 75 90 105 120
9720 9722 9730 9750 9765 A B DOP


NITROCELLULOSE MIGRATION
(modified V.F.I. Sward Rocker Test—3 days at 50°C)
% SOFTENING
0 10 20 30 40 50 60 70 80 90 100
9720 9722 9730 9750 9765 A B DOP

now the most complete line of low cost polymeric plasticizers in the industry

join famous Plastolein® 9720

POLYMERIC PLASTICIZERS FOR MANY USES

	PLASTOLEIN 9720	PLASTOLEIN 9722	PLASTOLEIN 9730	PLASTOLEIN 9750	PLASTOLEIN 9765
Coated upholstery fabrics	●	●	●	●	●
Unsupported films	●	●	●	●	●
Baby wear	●	●	●	●	●
Wall coverings	●	●	●	●	●
Vinyl-metal laminates	●	●	●	●	●
Industrial tapes		●	●	●	●
Shoe constructions	●	●	●	●	●
Surgical tapes				●	●
Plastisols, organosols	●	●	●	●	●
Coated paper	●	●	●	●	●
Pigment grinding	●	●		●	●
Refrigerator gaskets					●
Flooring	●	●	●	●	●
Hospital sheeting					●
Crash pads				●	●
Vinyl foam	●	●	●		

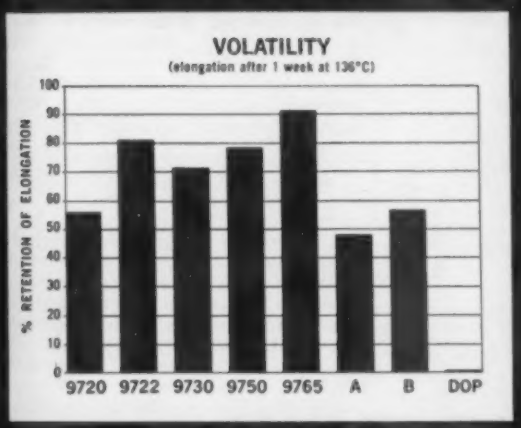
Emery

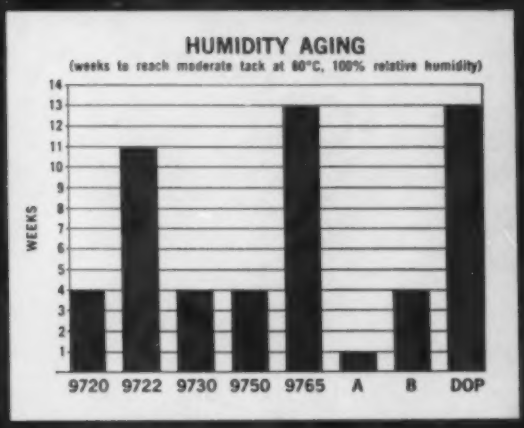
EMERY INDUSTRIES, INC.
Organic Chemicals Division
Carew Tower, Cincinnati 2, Ohio

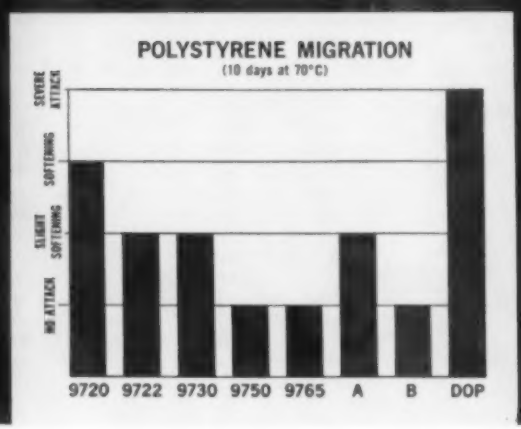
Vopcolene Division, Los Angeles, Calif.,
Emery Industries (Canada) Ltd., London, Ontario,
Export Division, Cincinnati, Ohio

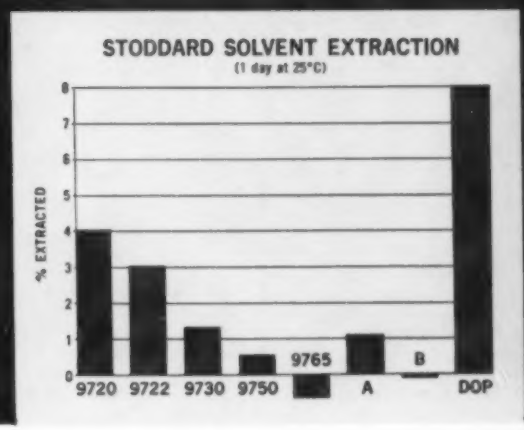
important properties against two leading competitors

Polymeric Performance At Efficiency Concentration (Modulus = 1300 ± 100)









For more information check Readers' Service Card

Flexible polyolefin copolymer

Dow Chemical Co. has developed a soft, highly flexible copolymer of ethylene and ethyl acrylate with end use characteristics similar to flexible vinyls. The material is called Zetafin and is available in three formulations, Zetafin 30 for extrusion and blow molding applications, 35 with antiblock additives for thin gage film applications, and 70 for injection molding use.

According to Dow, there is no thermal degradation during fabrication with Zetafin, and compounding except for color is unnecessary so that plasticizer migration is no problem. Zetafin formulations flow much more easily than equivalent melt index, low density polyethylene, and lower cylinder temperatures in injection molding can be used to obtain faster molding cycles. An economic factor over flexible vinyls is that up to 35% low cost filler can be added to Zetafin without greatly affecting physical properties.

Some typical properties of the three grades of this new copolymer follow:

	Zetafin 30		Zetafin 35		Zetafin 70	
Melt index	2.5		2.5		18.5	
Density	0.928		0.952		0.929	
Low temperature brittleness °C.	—70		—70		—70	
Hardness Shore A	90		35		88	
Shore D	35				30	
	Inj.	Comp.	Inj.	Comp.	Inj.	Comp.
Tensile strength at yield, psi.*	600	700	600	500	425	450
Ultimate tensile strength, psi.*	1250	2000	1250	2000	800	1200
Elongation at break, %*	350	700	350	700	300	700
Tensile modulus, psi.**	6700	—	6100	—	4600	—

*Test specimens strained at 2 in./min.
**Test specimens strained at 0.5 in./min.

The material has been evaluated with encouraging results for applications in toys, for place mats, draperies and table cloths, acording to Dow. Injection molded items have a high degree of flexibility and surface gloss.

Readers' Service Item 14

Polyester-type plasticizer

TXP-126 polyester-type plasticizer is a permanent, primary plasticizer for vinyl formulations (especially plastisols) available from Eastman Chemical Products, Inc. It is also compatible with cellulose acetate butyrate, ethyl cellulose, cellulose nitrate, and phenolic resins as well as with polyvinyl chloride in resin to plasticizer ratios from 1:1 to 1:4 and with polyvinyl acetate and polystyrene in ratios from 1:3 to 1:4. It has low viscosity and freezing point, excellent boiling water and hydrolytic stability, low yield values for easy initiation of flow and excellent viscosity stability in vinyl plastisols, and excellent electrical properties in vinyl insulation compounds.

TXP-126 plasticizer exhibits good mechanical properties and permanence in calendered film and sheeting and in extruded formulations with adequate resistance to soapy water extraction.

This plasticizer is a useful modifier for cellulose nitrate and cellulose acetate butyrate lacquers and in typical formulations produced physical properties comparable with those obtained with dioctyl phthalate and dibutyl phthalate.

The low specific gravity of TXP-126 plasticizer offers potential savings to plastic processors. For example, in comparison with a competitive plasticizer in a typical vinyl formulation at equivalent concentrations based on plasticizer activity, TXP-126 modified vinyl had a specific gravity 0.023 less than that of a film containing the second plasticizer, representing a signficant difference of 0.8 lb./cu. ft. of processed vinyl.

Some properties of TXP-126 plasticizer are as follows: Specific gravity, 20°/20°C., 1.00-1.01; color, Gardner scale, 2 max.; acid number, 5 max.; hydroxyl number, 20 max.; molecular weight, 530; saponification equivalent, 137; boiling point, 760 mm., °C., 331; Heat test, (2 hrs. @ 220°C.), % acid, 0.14; boiling water stability, % hydrolyzed after 96 hrs., 0.509; hydrolytic stability, % saponified in 0.5N NaOH after 7 hrs., 5, after 16 hrs., 8; freezing point, °F., —29; and Brookfield viscosity, cp., 25°C., 156.

Readers' Service Item 15

Also worth mentioning—

☐ Blane #312, a low temperature vinyl jacketing material designed to meet the military specifiations, JAN-C-17C, MIL-C-915A, and MIL-C-2194D, has been introduced by the Blane Corp. The new compound developed for coaxial and navy shipboard cable has good flexibility, excellent retention of elongation after aging, exceptionally smooth surface, and outstanding low temperature characteristics, it is said.

Readers' Service Item 16

☐ Trulon 750 and 760 vinyl chloride-vinyl acetate copolymer resins have been added to the line of the Thompson Chemical Co. Both resins are dry, free flowing, and white. Both have a specific gravity of 1.36, a volatile content of 2% max., vinyl acetate content between 13 and 15%, and a bulk density of 28 ± 2 lbs./cu. ft. The specific viscosity, 0.4% in nitrobenzene @ 25°C., for Trulon 250 is 0.21 ± 0.02, and for Trulon 760 is 0.17 ± 0.02.

Readers' Service Item 17

☐ Magnus Mold-Slic, a silicone spray for plastic fabricators, has been introduced by Magnus Chemical Co. The material is economical to use, is fume-free, provides for fewer rejects, and allows more rapid unloading of molds than available mold releases of comparable cost, it is said.

Readers' Service Item 18

☐ Eccomold L-70 is an extremely low loss, high temperature laminating resin available from Emerson & Cuming, Inc. A one-component material, it is supplied at a viscosity which assures thorough wetting of the fabric. When used with quartz or fiberglass fabric, laminates capable of service at 500°F. are produced. The dielectric constant of an Eccomold L-70 and polypropylene fabric laminate is K2.15 and the dissipation factor is 0.0008.

Readers' Service Item 19

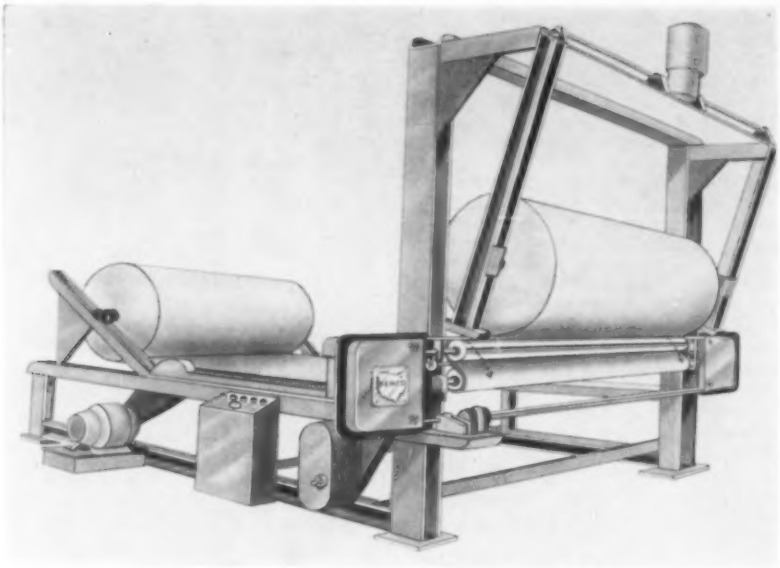
☐ Monoplex S-74, a monomeric epoxy-ester, stabilizing, low-temperature type plasticizer for PVC has been announced by Rohm & Haas Co. It was developed to provide decreased volatility while maintaining good low temperature flexibility and ability to stabilize PVC against the effects of heat and light. The low viscosity and light color of this plasticizer simplifies formulation and processing of PVC compounds, it is said. Resistance to extraction by soapy water is improved.

Readers' Service Item 20

☐ Miracle CA-25 contact cement, a synthetic rubber base solvent type adhesive for bonding plastic laminates to wood, metal, plastic or glass surfaces, is available from Miracle Adhesives Corp. Supplied at a consistency suitable for brush, comb or machine application, it gives coverage of about 150 square feet per gallon, and has shelf life of a year or more. The bond is permanent, flexible, and resistant to water, alcohol, alkali, and many acids.

Readers' Service Item 21

New Equipment



Circumferential paring machine for synthetic foam.

Urethane paring machine

Falls Engineering and Machine Co. has developed a circumferential paring machine for fabricating logs of synthetic foam into semi-continuous sheets for such uses as clothing innerlinings and rug backing. A log of synthetic foam is placed on the machine's core bar and is then automatically rotated into the cutting head in such a way that a continuous sheet of foam is pared or peeled from the log. The pared stock is threaded between two compression rolls and then passes to a wind-up assembly which rolls the stock up on a two or three inch paper core for use in laminating to cloth.

Cutting speed is variable from one to 300 feet per minute and adjustable while the machine is in operation. An additional speed variation is provided between the wind-up mechanism and the compression rolls so that pared stock can be wound up without stretching. Foam can be pared into a sheet as thin as 1/16th of an inch, and different thicknesses are obtained by changing lead screws in the cutting head assembly. This can be done in five minutes or less.

The paring machine can handle a log of foam up to 84 inches wide and 48 inches in diameter. The compression rolls are designed so they can be dropped away from the cutting blade if the foam log is square and must be rounded before actual paring begins.

Readers' Service Item 21

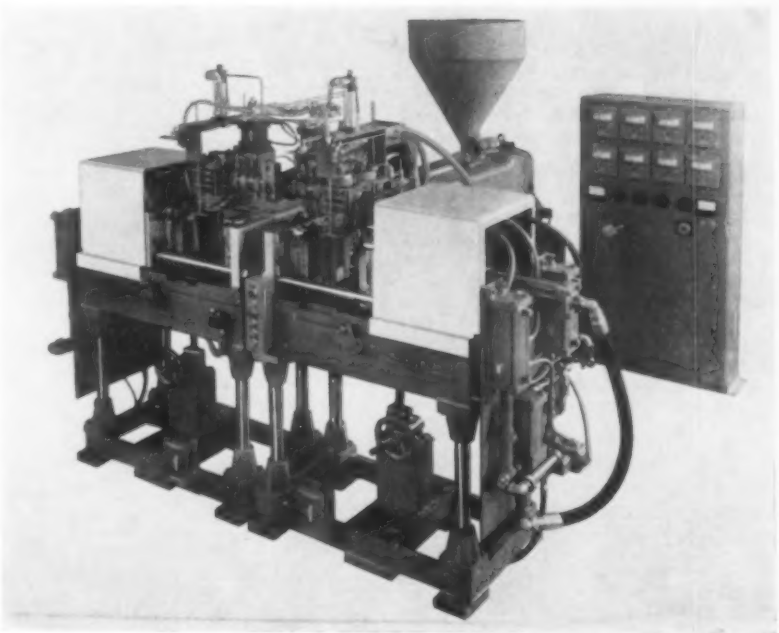
Eight blow molding units

The plastics machinery division of the Producto Machine Co. has introduced the Versa-Blow series of eight different models of blow molding machines in a wide range of speeds and capacities. There are four single-press and four double-press models available, all with modular building-block construction to allow easy adaptation of Versa-Blow components for specific needs.

Some of the advantages of these machines are described as follows: Each molding press has three-way micro-positioning adjustments for centering mold under parison. Each press has positive, high-speed equalized opening and closing, insuring dead center mold alignment with ample clamping force for high pressure blowing. There are high-speed, horizontal in-line, self-cleaning accumulators for perfect parisons available with infinite shot size range. Three separate head adjustments regulate parison weight, concentricity and straightness. Extruder screw and breaker plate may be removed without removing manifold assembly or accumulator. Platen "daylight" opening is adjustable and accommodates dies of various thicknesses without shimming.

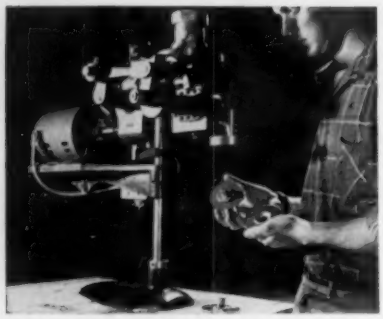
Double presses can be operated independently of each other, with one press kept inactive (if necessary). Conversion from single to double or double to single press can be accomplished economically.

Readers' Service Item 22



Versa-Blow double press model VD-2.

For more information check Readers' Service Card (p. 73)



Metering pump for viscous or semi-viscous materials.

Accurate variable discharge metering pump

Robinson Machine Co., Inc. has announced the availability of a positive displacement, variable discharge, gear-type metering pump which will accurately deliver vinyl plastisols and similar materials into a 2⅝-inch cylindrical disc. Applications would include cementing, filling, potting, and sealing.

The discharge of this metering pump is controlled by an adjustable ratchet mechanism, a single revolution clutch, and a constantly running motor. When the clutch is released, a driven crank describes a 100° arc; a pawl with a cam follower attached to the driven crank engages a number of teeth of the ratchet determined by the selector lever. The cam follower rides on a cam attached to the selector lever, which can be locked into any one of 20 positions by a spring-loaded detent pin. A direct indication of the number of ratchet teeth that will be engaged can be determined by the numbered detent holes. Thus, accurately measured quantities of material can be predetermined and instantaneously selected and dispensed repeatedly. The adjustment can be made without tools, even while the pump is running. The pump can also be arranged to meter in a variety of diameters.

Adhesives, plastisols, resins, epoxies, silicone greases, and polyesters can be handled by this pump. Feed can be either from a mounted five gallon tank or from a mother tank through a two inch compression coupling. Production rates as high as 90 units a minute have been achieved with assistance of automatic feeding tables or conveyors.

Readers' Service Item 23

Largest automatic transfer molding press

A 200-ton Model 741 AT automatic transfer molding press that incorporates automatic feeding, preheating, and loading of preforms, and automatic separation of cull and runners from finished parts, has been built by F. J. Stokes Corp.

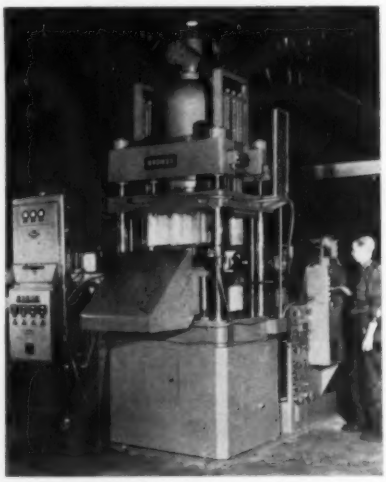
Preforms enter the preheater from a vibratory bowl via an automatic stacking and counting device controlling the number of preforms per shot. After the charge is preheated to the proper temperature, the hot stack of preforms moves on a chain-driven conveyor into the molding area, where it is dropped into the transfer pot.

The pressure in the clamping ram and the transfer ram of the press are independently controlled. The design provides for three-speed clamping; that is, a high-speed approach at 250 inches per minute at low pressure, an intermediate slowdown, and a final clamping phase at 45 inches per minute (adjustable) at higher pressure. The bottom transfer ram, which has a capacity of 40 tons, has a high-speed approach phase at 360 inches per minute, followed by a pressing phase at a speed adjustable up to 75 inches per minute.

The new press provides for both automatic degating and sorting of the finished molded pieces to separate them from the cull and runners, the latter in three separate motions. The first, a horizontal motion, brings in a tray to cover the lower half of the cavity as the press opens, the parts remaining in the upper half of the mold. The second, a downward one, ejects the parts and the cull and runner, each on its own ejection pins. The third, another horizontal one, moves in two combs, one above the other. As the ejection pins are withdrawn, the cull and runners fall onto the tray and the parts are caught on the lower comb, while scrapers now move in horizontally to sweep the parts into one chute and the cull and runners into another.

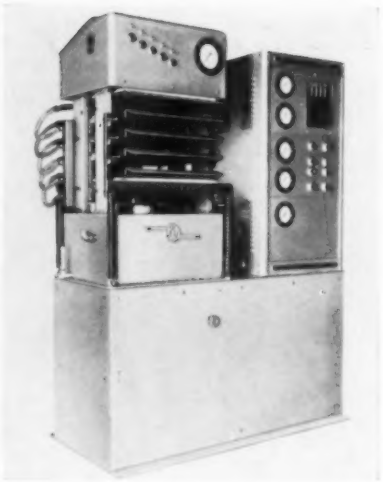
In addition, the press incorporates two special safety provisions as follows: (1) Automatic detection of short shots or over-charging, either of which brings immediate interruption of the press cycle. (2) Automatic detection of an incompletely-closed mold, in order to prevent flashing of the mold.

The standard mold area of the press, left to right and front to back, is 30 by 24 inches. The press itself is 149 inches high; the height from floor to platen is 44½ inches. Floor space required, excluding preheater, left to right and front to back, is 62 by 150 inches.



Model 741 AT Stokes 200-ton automatic transfer molding press.

Readers' Service Item 24



Electrically heated laminating press.

Laminating press

Kingsbacher Murphy Co. has recently designed and constructed a self-contained laminating press which includes a motorized hydraulic unit, five electrically heated and water cooled platens 19 by 19 inches, and a control panel. Platen heating may be adjusted to 600°F. and can be cut off any platen by individual toggle switches. Platen temperature indicators are located on the control panel.

The operation of the motorized hydraulic unit is controlled by push buttons on the control panel located to the right of the press frame. Laminating pressures may be varied up to 75 tons with a handwheel located below the press frame. Complete time sequence for laminating may be preset to control platen closing and opening, application of platen pressure, and time needed for platen heating and water cooling. Each operation may be controlled individually without the use of the timer when so desired.

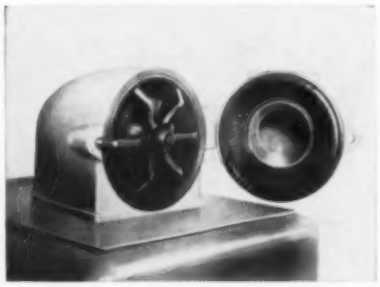
For usual operation, items to be laminated are inserted between the platens, the sequence timer is preset, and a button is pressed to initiate press action. At the end of the operating cycle, the platens open and laminates are removed.

Readers' Service Item 25

Lab size grinding mill

The Pallmann laboratory mill, developed by Pallmann Pulverizers Co., Inc., will crush, pulverize, shred, mix, and otherwise reduce to any particle size dry materials that are soft to medium-hard and do not exceed ⅜ of an inch grade. The desired particle size is obtained without the use of screens or sifting devices.

Equipped with a 2¾ hp motor running at mill speeds of either 4500 or 9000 rpm, the unit employs a 7⅛ inch grinding chamber that will handle quantities of from 100 grams to 44 pounds in a single pass. Continuous size reduction is also possible. Developed especially for research and development work, the mill is capable



Pallmann lab mill grinding chamber.

of handling many types of materials, including some thermoplastics, without the use of coolants.

The mill is delivered complete with base, filter bag and collecting container; installation requires no more than a 115 volt electrical connection. Additional equipment is available for special set-ups.

Readers' Service Item 26

Flow-level control

The Flo-Level Model L201 level control has been developed by Flo-Tronics, Inc., Electronic Controls Div., as a fully self-contained capacitance probe-type material level control for direct mounting on bins, hoppers, tanks or other containers holding dry, semi-dry or liquid materials. The instrument is said to be ideal for use with such light weight, low capacitance materials as plastic powders and pellets.

Presence or absence of material is detected by the probe through changes occurring in the electrostatic field. A signal is given to the control circuit which activates a two-way fail-safe snap action relay to effect operation of the filling or shut-off device.

Probe is integral with explosion-proof control casing. Self-contained feature eliminates extra cost of labor of installing cables between sensing device and remote control box.

Standard probe length is six inches with longer lengths available on request. L201 controls are supplied for either 110 or 220 volt power supply.

Readers' Service Item 27

Also worth mentioning

☐ Webalarm, a go, no-go gage that signals audibly or visually when the width of a moving web falls outside preset tolerances, has been announced by Matrix Controls Co. Easily installed on calenders, tenters, dryers or extruders, or inspection perches, its "snagproof" wands are used to sense each edge of the web. The instrument is not affected by sideslip or speed variation of the moving material.

Readers' Service Item 28

☐ Two ratchet and reverse sequence forms have been added to General Electric Company's line of cast iron, snap action foot switches for applications requiring foot operation of a machine or process cycle.

The CR150 A8 ratchet form is designed to meet requirements where maintained control is needed.

The CR150 A7 reverse sequence two-stage foot switch has two precision snap action switches each, with one normally open and one normally closed contact which operate in reverse sequence to the standard CR150 A3 two-stage foot switch.

Readers' Service Item 29

☐ The Series 100 is the smallest in Wallace & Tiernan, Inc.'s line of plunger metering pumps for urethanes. Capacities range from 0.95 gph. vs. 1,200 psi. to 50 gph. vs. 100 psi. With one or two liquid ends, overall area is less than two square feet.

Readers' Service Item 30

☐ KamRu Products Corp. has introduced a two-color lid printer which prints one or two lids per revolution at speeds to 100 rpm. Two colors are printed in register at one pass by paste ink, rubber plate, or offset methods.

Readers' Service Item 31

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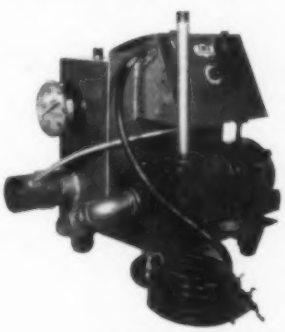

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Plastics Applications

Floating chaise

The last word in equipment for relaxation on water is a non-sinkable chaise introduced by Argo Industries Corp. Ethafoam, flexible polyethylene foam manufactured by Dow Chemical Co., provides the buoyancy. Argo makes an unusual water companion—a floating coaster of polyethylene foam.

The floating chaise consists of two round outrigger floats, four inches in diameter and 54 inches long, plus an adjustable backrest, all of polyethylene foam. These three parts are attached to a tubular aluminum frame which holds a hammock of laminated vinyl-nylon fabric.

Readers' Service Item 41

Plexiglas covered bridge

A completely enclosed pedestrian bridge with an acrylic archway has been installed between the Denver-Hilton Hotel and the May - D & F department store in Denver, Colo. Glass was considered impractical for the curved enclosure because of the breakage hazard and forming problems, but Rohm & Haas's Plexiglas acrylic met the need.

The 86 foot long bridge enclosure is in the form of a semi-circular arch with a 10 foot, 1 inch radius. Semi-circular I-beam, steel ribs provide the framework. For the transparent enclosure, quarter-inch Plexiglas in 28-inch wide sheets was used, four sheets joined end-to-end to make the full enclosure between each pair of ribs. The acrylic sections are sealed along the vertical seams with cork-neoprene gaskets placed next to the steel support on the inside and between the Plexiglas and a two inch steel retainer strap on the outside. A solvent-cemented V-joint is used where the plastic sections meet at the ends. The transparent plastic enclosure sections were fabricated by Regal Plastics, Englewood, Colo.

Readers' Service Item 42

For more information check Readers' Service Card (p. 73)

Vinyl insulation sleeving

Borden has developed a transparent vinyl insulation sleeving said to combine outstanding resistance to heat, fungus, and oil attack. Called Resinite Hi-Heat 105C, it is designed for electric motor insulation and over transformer leads and other applications in both ground-employed and airborne electronic assemblies.

Average rated dielectric strength is 1,000 vpm. Working temperature is 221 to —10° F., with continuous operations to 105° C. Self-extinguishing in five seconds, the sleeving has a minimum tensile strength of 2,900 psi., and burst strength of 75 psi. It resists alcohols, oils, and most common acids.

Readers' Service Item 43

Teflon-lined hose

Electrically heated Teflon-lined hose, designed for conveying hot melts and viscous materials without heat loss, is manufactured by Sta-Warm Electric Co. The Teflon lining is shielded by an outer stainless steel braid enclosed in an extruded protective Teflon sleeve.

Flow may be forced by gravity, pressure tanks, or pumps, so that material will reach point of application at a usable consistency. The hoze is adaptable for valve, nozzle, or spray gun.

Readers' Service Item 44

Wirebound polyethylene drums

Containers consisting of inner cylindrical polyethylene drums and outer protective octagonal wirebound overwraps are reportedly bringing shipping, handling, and storage economies to shippers and

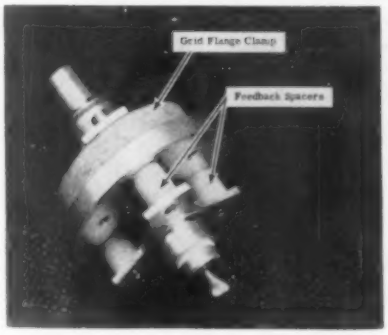
Octagonal wirebound containers are transported for filling.

receivers of chemicals formerly shipped in steel drums or glass carboys.

The octagonal wirebound overwraps permit containers to be nested on pallets or in a relatively small storage area. The necks of the polyethylene drums protrude through the ends of the overwraps for pouring ease, but are below the level of the end cleats. Thus, pallets loaded with filled containers can be stacked safely and securely.

The polyethylene cylinders are produced by Delaware Barrel & Drum Co., and the octagonal wirebound overwraps by wirebound container manufacturers. Octagonal wirebound containers are transported for filling.

Readers' Service Item 45



Feedback assembly for tunable stalos.

Fluorocarbon oscillator parts

Pitometer Log Corp. has used a modified TFE composition for components of its S-band stable local oscillators (tunable stalos). Polymer Corp.'s Fluorosint comprises two critical parts in the feed back assembly — the grid flange clamp and the feedback spacers. The grid flange clamp positions the power tube diametrically, and the feedback spacers locate the tube axially.

The grid flange clamp is a 0.320-inch thick, 1½-inch diameter disc which is compressed between a segmented clamp and an aluminum ring. The prime reason for Fluorosint's selection in this application was its coefficient of thermal expansion; this valve is practically identical with that of the aluminum, used in the mounting plate. Therefore, there is no problem of distortion due to temperature build-up.

The feedback spacers, to which considerable pressure is applied, are machined from Fluorosint rod.

Readers' Service Item 46

PE bottled beverage cases

Union Carbide Plastics Co. announced recently that it was selling plastic cases for bottled beverages. The company is subcontracting production of the cases to established molders and will market them through normal beverage trade channels.

Injection molded of Union Carbide's DMD-7014 high density (0.960) polyethylene compound, the cases, known to the beverage trade as shells, weigh less than half as much as wooden shells and should effect appreciable economies in transportation costs for bottlers. The DMD-7014 compound provides shells with a high tensile strength over a wide range of temperatures, excellent color stability, and resistance to cracking or warping under normal usage.

Three models of the plastic shells are currently on the market, two for soft drinks and one for beer. Additional models will be introduced.

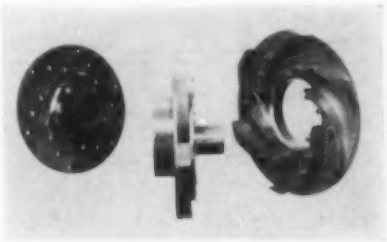
Readers' Service Item 47

Nylon water pump impeller

Tait Mfg. Co. required a material with high wear and abrasion resistance, rigidity, and low water absorption for the impellers in its submersible water pumps. It found that a molding of molybdenum disulfide and nylon was able to avoid damage and seizing caused by water-born abrasives.

The six-inch centrifugal submersible unit is used for commercial and institutional pumping. The nylon impeller is mounted inside the diffuser casing on a rotating shaft. It can move up and down the shaft within the limits of the diffuser casing. A stainless steel insert in the casing provides a bearing surface for the impeller's bearing hub.

The impellers, injection molded by American Insulator Co. from Polymer Corp.'s Nylatron GS, provide smoother water passage than the previously used brass. The material reduces wear between the bearing hub and steel diffuser insert, and requires no lubrication.



Snap fit pump impeller.

Readers' Service Item 48

Echo II prototype tested

A 135-foot diameter inflatable "supersatelloon," a prototype of Echo II which will be shot into orbit in 1962, has been designed and fabricated by the G. T. Schjeldahl Co. The prototype was recently test inflated to 18,000 psi. skin stress, more than four times the strength needed to survive orbital space flight, by the Goddard Space Flight Center of the National Aeronautics and Space Adminstration (NASA) at Weeksville, N.C.

The Echo II spheres are fabricated of laminated aluminum foil 0.0018 inch thick, on each side of Mylar polyester film 0.0035 inch thick. The laminate as well as the tapes that seal gores or segments of the giant Satelloon are bonded with Schjel-Bond adhesive, which will withstand the extreme temperature variations encountered in space.

The material used in the new Echo Satelloons is 50 times more rigid than the material used in Echo I. The thin alumi-

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num for the new Echo II spheres was developed especially by the Aluminum Co. of America. The rigidized spheres weigh about 500 pounds each and will be shot into space by means of a Thor Agena-B rocket vehicle. After the canister containing the folded-up Satelloon has been properly positioned in orbit, the Echo II sphere will be ejected and instantly inflated.

Sub-orbital tests of the ejection and inflating mechanism of the rigidized spheres will be made from the Atlantic Missile Range. The first rigidized Echo passive communications Satelloon will be launched into orbit from the Pacific Missile Range during 1962.

Readers' Service Item 49

Four commercial floor cleaning machines.

Cleaning machine components

Certified Chemical & Equipment Co. has introduced four commercial floor cleaning machines using the same two fiberglass-reinforced components in combination on all four machines. The two components are custom molded by Plastic Products Corp.

In the accompanying photograph, viewing from left to right, the first machine uses two of the large components to form the tank and housing for a rug shampooing machine. The large component is used alone on the next to form the tank on a portable pumping unit. The third application consists of the two components bonded together to form a combination motor housing and solution tank for a floor scrubbing machine. Finally, in the fourth machine, the two moldings are mounted end to end to form the tank and motor cover for a commercial tank-type vacuum cleaner.

Readers' Service Item 50

ICC-approved carboy

A 15-gallon all-plastic carboy that has been awarded Interstate Commerce Commission authorization to ship regulated chemicals without overpack, has been announced by Plastineers, Inc.

Made in the shape of a drum 17¼ inches in diameter and 20½ inches in length, the carboy can be easily rolled

and stacked. Empty weight is 17 pounds. The carboy is injection molded in two parts from a copolymer of polyethylene, then welded together by a patented process which provides a welded section actually stronger than the molded body. It has exceptional impact strength at low temperatures and is heavily reinforced at the center and ends.

The new carboy has passed all required tests of the Bureau of Explosives Association of American Railroads and the Manufacturing Chemists Association. Each unit is individually air-tested under water before shipment.

The new Plastineers model is designed to allow use of a standard polyethylene chemical pump, with which both small and large amounts of chemicals may be easily and safely dispensed without danger of spillage.

Readers' Service Item 51

Also worth mentioning—

☐ The modular control circuits of a series of electronic temperature controls offered by Electronic Processes Co. are encapsulated for protection against normal shock and vibration. According to the company, the epoxy protected electronic company, the epoxy-protected electronic temperature variation than will exposed circuitry.

Readers' Service Item 52

☐ Nopco Chemical Co. has developed a special formulation polyester urethane foam for garment interlinings. Nopcofoam Insulining is reported to provide closer knit appearance, better drape, and softer h..nd than other foams applied to garment fabrics.

Readers' Service Item 53

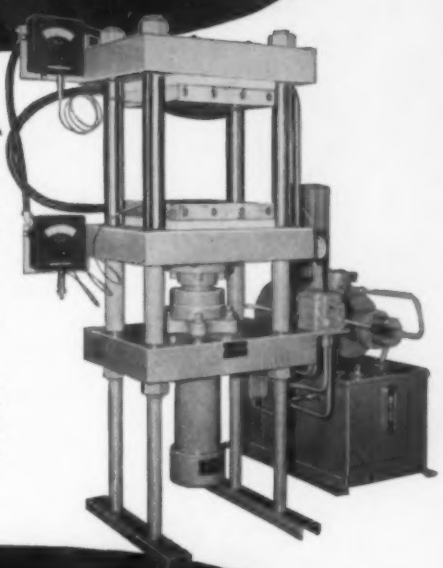
☐ Dumont Mfg. Corp. has received an order from Thiokol Chemical Corp. — Redstone division to produce reinforced plastic nozzles for the first and second stage rocket motors of the U. S. Army tactical Pershing missile. The nozzles will use metal only for attachment and lock rings.

Readers' Service Item 54

☐ New plastic utility cans blow molded of high density polyethylene for the sportsman, fisherman, and camper are available in red, green and yellow from Miller Safety Co. The cans, in one and three gallon sizes, come with a large, rugged carrying handle; both have special air vents for smooth easy pouring and the one gallon size has a swivel spout for pouring at any angle.

Readers' Service Item 55

want limited-production economy?



For all its savings in first cost and operation, this 50-ton RODGERS press gives you all the essentials for flexible, accurate molding. It has 14″ double-acting stroke, 14″ x 12″ platens with automatic heat control, and 18″ of daylight. It uses a 10 hp single-speed pump, with manual control.

Many other economy-line presses to choose from, standard or special. Behind them all — RODGERS' reputation for quality and reliability.

want high-production efficiency?

In automatic transfer molding, RODGERS gives you unmatched dry cycle speeds of 14 seconds; in compression molding, under 9 seconds! Changeover from transfer to compression, or from top to bottom ejection, requires only a turn of a dial. Full 2400-lb. holding force on molded parts reduces (or completely eliminates) use of troublesome springs ... greatly simplifies job set-up. Fully automatic from preheat to unloader. Model illustrated is rated 150 tons. Other models to 300 tons.

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Let's talk it over. Tell us your requirements, and we'll recommend the size and type press that will give you greatest return on your investment, for *your* type of work. MP-101D

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For more information check Readers' Service Card

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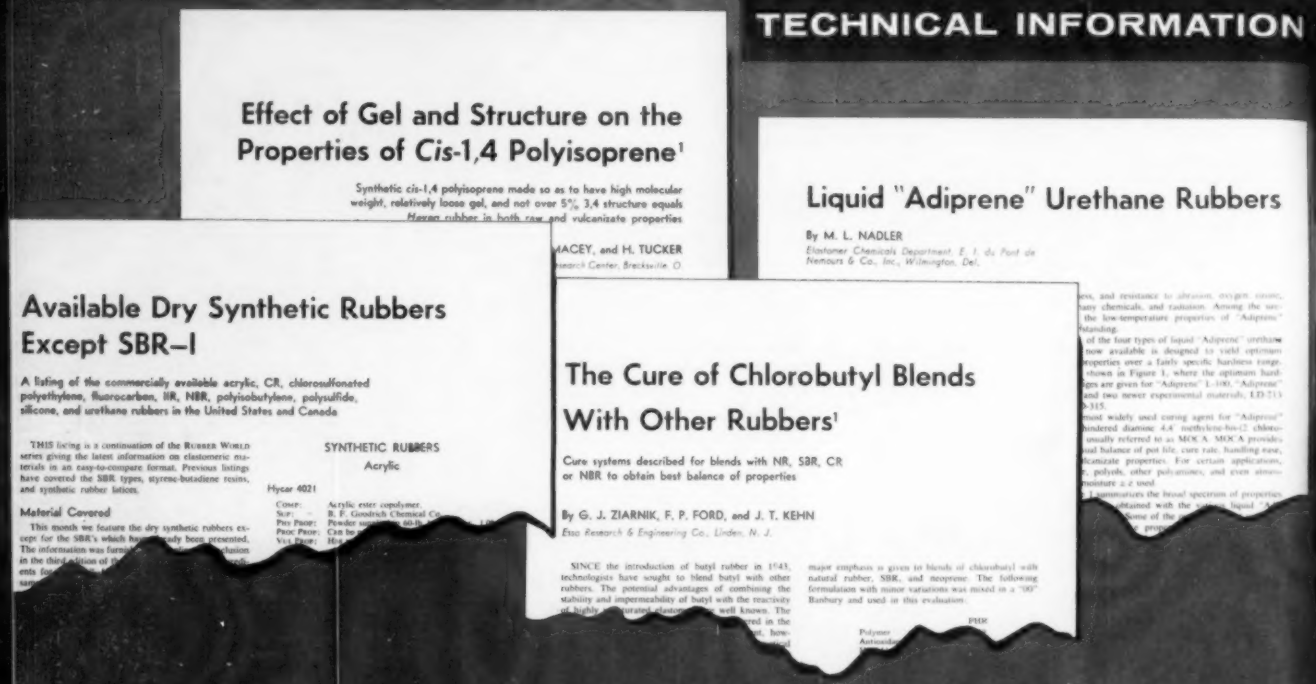

Effect of Gel and Structure on the Properties of *Cis*-1,4 Polyisoprene[1]

Synthetic *cis*-1,4 polyisoprene made so as to have high molecular weight, relatively loose gel, and not over 5% 3,4 structure equals Hevea rubber in both raw and vulcanizate properties

MACEY, and H. TUCKER

Liquid "Adiprene" Urethane Rubbers

By M. L. NADLER

Elastomer Chemicals Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Available Dry Synthetic Rubbers Except SBR–I

A listing of the commercially available acrylic, CR, chlorosulfonated polyethylene, fluorocarbon, IIR, NBR, polyisobutylene, polysulfide, silicone, and urethane rubbers in the United States and Canada

THIS listing is a continuation of the RUBBER WORLD series giving the latest information on elastomeric materials in an easy-to-compare format. Previous listings have covered the SBR types, styrene-butadiene resins, and synthetic rubber latices.

Material Covered

This month we feature the dry synthetic rubbers except for the SBR's which have already been presented. The information was furnished in the third edition of the

SYNTHETIC RUBBERS

Acrylic

Hycar 4021

Cure:
Sp.G.:
Dry Proc:
Proc Proc:
Vis Proc:

Acrylic ester copolymer.
B. F. Goodrich Chemical Co.
Powder
Can be

The Cure of Chlorobutyl Blends With Other Rubbers[1]

Cure systems described for blends with NR, SBR, CR or NBR to obtain best balance of properties

By G. J. ZIARNIK, F. P. FORD, and J. T. KEHN

Esso Research & Engineering Co., Linden, N. J.

SINCE the introduction of butyl rubber in 1943, technologists have sought to blend butyl with other rubbers. The potential advantages of combining the stability and impermeability of butyl with the reactivity of highly unsaturated elastomers are well known. The

major emphasis is given to blends of chlorobutyl with natural rubber, SBR, and neoprene. The following formulation with minor variations was mixed in a "00" Banbury and used in this evaluation:

Polymer
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PHR

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With his new responsibilities, time is more valuable than ever to the rubber chemist/executive. Today's RUBBER WORLD

RUBBER CHEMISTS

ON MANAGEMENT INFORMATION

Urethane Rubbers Growing in Use
Properties will enable material to compete in both plastics and rubber markets, take over some jobs from metals
By STUART V. d'ADOLF
New Tire Construction Joins Nylon and Rayon
Seiberling's new "Hytex" tire with both nylon and rayon cords is designed to provide safety and comfort, ease multiple inventories, and eliminate the question, "Which should I buy?"
For Safer Mixing
The Lunn-Type Safety Bar
Moving the safety bar down to waist level helps keep operator out of danger and permits stopping mill even if both hands are caught
Conveyors Roll into New Fields
Make gains in passenger transportation, food processing, mail and baggage handling
A special RUBBER WORLD report
By STUART V. d'ADOLF

reads fast, projects ideas fast. It has been restyled with a fresh, modern, clean-cut look. The wordage is economical—and meaningful. You get more out of it in less time.

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New Literature

For more information check Readers' Service Card (p. 73)

"Automatic Temperature Control of Plastics Fabricating Equipment." Bulletin 1070. Sarco Co., Inc. 6 pages. The brochure discusses problems and offers solutions in the precise automatic control of fabricating equipment temperatures.

Readers' Service Item 61

"Installation, Care, and Maintenance of Teflon Coated Equipment." General Plastics Corp. 4 pages. Instructions for same.

Readers' Service Item 62

"Blow Molding Today and Tomorrow." Hercules Powder Co. 18 pages. A manual on this process, including theory, markets for blown products, decorating, engineering mold design and construction, and technical data on materials. Profuse examples and illustrations.

Readers' Service Item 63

"Drum Gauging Chart." U. S. Industrial Chemicals Co. 1 page. This wall chart will determine how much liquid is left in a partially used drum. It is used to convert wet inches of stick measurement of ethyl alcohol or other liquid with a similar coefficient of cubical expansion into gallons of liquid.

Readers' Service Item 64

"Information on Hercules Polypropylene." Hercules Powder Co. 21 pages. This attractively illustrated brochure discusses structure, characteristics, and processing (injection molding, extrusion, and fabrication) of Pro-fax polypropylene. Photographs include some interesting applications; tables and figures cover properties of molded parts, comparative volumes of equal weights of different resins, chemical resistance, major markets for polypropylene, etc.

Readers' Service Item 65

"Recommended Revision of CS228-60, Plastic Drain and Sewer Pipe and Fittings." TS-5527. Commodity Standards Division, U. S. Department of Commerce. 4 pages. Eight deletions and/or additions to CS228-60 provide a means of broadening the application of plastic drain and sewer pipe to include larger pipe for use in sanitary and storm sewers.

Readers' Service Item 66

"Laboratory Pressure Forming Machine." Producto Machine Co. 1 page. Illustration and specifications of Model P-88.

Readers' Service Item 67

"Plastics Molding Machinery." Bulletin 600. Farrel-Birmingham Co., Inc., Watson-Stillman Press division. 12 pages. The brochure supplies illustrations and specifications of horizontal and vertical plastics injection molding machines, compression and transfer molding presses, and laboratory and general purpose presses.

Readers' Service Item 68

"Hydraulic Presses and Special Machinery." Bulletin T-61-108. Taccone Corp. 4 pages. A line of hydraulic presses is illustrated.

Readers' Service Item 69

"Standard Duty Rotoblast Barrels." Bulletin No. 706. Pangborn Corp. 16 pages. Features of blast cleaning barrels, with specifications of each of five sizes. Case histories on use of blast cleaning barrels.

Readers' Service Item 70

"Uni-Crest." United Cork Cos. 8 pages. Descriptions of expandable and expanded polystyrene. Application of regular and self-extinguishing forms.

Readers' Service Item 71

"Ideas in Flexible Plastic Fabricating." Polo Plastics Co. 1 page. A series of case histories on applications of vinyl and other flexible plastics. Volume I, no. 1, covers design, materials, and production of an identification bracelet for hospital use.

Readers' Service Item 72

"Raw Materials for the Fiberglas Reinforced Plastics Industry." Berton Plastics, Inc. Catalog of Fiberglas, glass fabrics, resins and pigments, parting agents, catalysts and accelerators, and miscellaneous chemicals.

Readers' Service Item 73

"Buton Resins for Surface Coatings." Enjay Chemical Co. 21 pages. Information on properties, uses, and application and curing of styrene-butadiene coatings resins. Properties of films, with effects of different cure times and temperatures.

Readers' Service Item 74

"Blast Cleaning Equipment." Guyson Industrial Equipment Ltd. 6 pages. Two brochures describe the T/40 Guyrota and SBP/40 Guyson deflashing machines. They include specifications, illustrations, and features.

Readers' Service Item 75

"Solution Resins." Service Bulletin G-15. B. F. Goodrich Chemical Co. 24 pages. The booklet provides information on preparation and application of vinyl solution coatings. Detailed data on compounding and formulating solutions for many uses.

Readers' Service Item 76

"Hexachlorocyclopentadiene." Bulletin No. 65. Hooker Chemical Corp. 8 pages. Chemical reactions of this material used to prepare, among other things, intermediates for paints and fire-retardant urethane foams and laminates. The booklet includes handling information and detailed properties.

Readers' Service Item 77

"Medical Products in Scotchpak Films." Folder No. 1. Minnesota Mining & Mfg. Co. 4 pages. Advantages of packaging medical products in heat-sealable polyester film, fields of application, and film recommendations and permeability data are covered.

Readers' Service Item 78

"Epoxy E-Form Pellets for Adhesive Applications." Bulletin #6. Epoxy Products. 4 pages. Bond strength, characteristics, production bonding techniques, and curing are discussed in separate sections. Typical applications are described in terms of problem and solution.

Readers' Service Item 79

"Injection Nozzles." Header Tool Co. 4 pages. Illustrates and specifies 16 nozzles and adaptors.

Readers' Service Item 80

"Color Chip Booklet." Plastics Color Co. 33 pages. Seventy-two color chips of dry color and color concentrates for all thermoplastic materials. Includes specialty colors such as pearls and mottles.

Readers' Service Item 81

"Schenectady Presents SP-134." Schenectady Varnish Co., Inc. 4 pages. Technical data on a light colored, heat reactive, phenolic resin for industrial and general purpose elastomer adhesives.

Readers' Service Item 82

"Future Sealers." N.V. Machinefabriek Verwachting, represented by Bedford-National Co. 8 pages. Heat and vacuum sealers for film are illustrated and described.

Readers' Service Item 83

Book Reviews

"Handbook of Chemistry and Physics." Forty-second edition. C. D. Hodgman, Editor. Chemical Rubber Publishing Co., 2310 Superior Ave., N.E., Cleveland, O. Cloth, 5 by 7½ inches, 3,481 pages. $12.00.

As is customary at frequent intervals, the editors of this handbook have published a new edition with many new, modified, and expanded tables. Among the revisions are atomic weights, electronic configuration of the elements, analytical reagents, definitions, and trade names of plastics.

The last section is at least three years old, and does not include such materials as polypropylene and polycarbonate. Judging by the trade names chosen for inclusion, the list was not compiled by a plastics expert. The trade name 3M is listed as standing only for epoxies. These minor failings are indicative of the difficulty in keeping a reference of this size up to date.

This handbook, a must for the shelf of every chemist, physicist, and engineer, contains more than 20 new tables. Among them are three covering dissociation constants of acids and bases, and four on surface tension of organic and inorganic solutes in both water and organic solvents. Many tables list physical properties. Besides those of plastic, properties of woods, rubbers, and pigments are of interest. There are many tables on physical chemistry.

The general chemical tables are interesting and valuable. However, the section on cements and adhesives does not include some of the recent polymers which have been in use for five years. Properties of commercial plastics are listed by resin type and chemical class, along with applicable ASTM specifications and test methods.

The physical constants of almost 9,000 organic compounds are tabulated, and there seems to be no end in sight. This listing appears to be very up to date.

For engineers and physicists working with ablation studies on reinforced plastics, the meteorological data will be valuable, even though these have not yet been updated to include the results of the IGY.

"Manual for Plastic Welding: Polyvinyl Chloride." G. Haim. Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y. Cloth, 5½ by 8½ inches, 324 pages. $15.00.

The title of this book is much more limited than the contents. As a manual for welding PVC, it encompasses information not only on the basic characteristics of this material (which would have to be known by anyone working it), but on secondary processing and applications as well. Abstract discussions of processing are only helpful when they are backed up by practice; therefore, the significant applications of PVC welding are covered thoroughly.

After some of the usual discussion of the chemistry, properties, and manufacture of PVC, the author explains the availability of rigid and plasticized PVC sheet, extrusions, etc., for secondary processing. He goes into custom work as well as standard. He then presents detailed information on the theory and practice of welding, including equipment, processes, and types of welds. A whole chapter is devoted to hot-gas welding. Finally, he discusses the working of PVC in tank and vat linings, pipe lines, ducts lines, construction, and industry. The latter chapters include data not only on welding, but on fabrication, installation, and finishing. It is in this sense that the manual outgrows its title.

A six-page color section illustrates the technique of welding, types of welds, and common faults. This section, which can be purchased separately for $3.00, is an excellent inclusion.

"Transactions of the Society of Rheology." Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. Vol. 3, 1959. Cloth, 6 by 9¼ inches, 216 pages. $6.75. Vol. 4, 1960. Cloth, 6 by 9¼ inches, 368 pages. $10.00.

Volume 3 includes papers on polyethylene adhesive joints, stress analysis, theory and analysis of peel adhesion. torsional pendulum viscometers, behavior of polyolefins, deformation of PVC, and These papers, and others presented at the Society of Rheology meeting, November 5-7, 1958, comprise the volume. For those papers which were not included in their entirety, abstracts are provided. For each complete paper, there is a synopsis.

The second of these two volumes is organized in similar fashion. It is a record of the society's meeting in 1959. Two special symposia on mechanics of continua and on adhesion and rheology were also presented. Papers of interest include those on modulus measurement, stress-optical coefficients and stress-optical properties of silicones, behavior of molecules in fibers, and measurement with the Brabender plastograph.

Much of the text is supplemented with photographs and charts.

"A Study of Fire Safety Aspects of Plastics in Building Construction." C. H. Yuill. Manufacturing Chemists Associations, Inc., 1825 Connecticut Ave., N.W., Washington 9, D. C. Paper, 8½ by 11 inches, 107 pages. $5.00.

This publication is the result of a one-year study carried out by Southwest Research Institute for the MCA Plastics Group. According to the publication, "The purpose of this study was to review the fire protective function of building elements and the fire safety provisions of building codes in relation to the use of plastic building materials. The specific objective was to determine what further steps could be taken by the industry to develop fully the potential uses of its building products and how such uses are affected by building codes." To carry out this purpose, the actual and potential uses of plastic building materials in a single-family residence and a multi-story office building are considered and examined.

Essentially, the report indicates that it is up to the plastics industry to effect an increase in the use of plastics in buildings. Present building codes would permit much greater use of plastics than is current, but education of safety and regulatory people, contractors, and the public is needed. There is also a need for definition—many plastics products are classified as being self-extinguishing, a totally worthless value when applied to buildings. Industry people should also investigate the use of plastics as fire-resistant materials. Even though plastics are consumed by fire, they can serve as insulation for heat-vulnerable materials such as steel to delay collapse caused by intense heat.

Plastics are relatively new and therefore must be adapted to building codes, while the latter, being largely empirical, are open to change. Thus, increased use necessitates change from both sides.

The study reviews the whole subject of fires in buildings, tabulating fire hazards, permissible uses of plastics in buildings, and possible fire safety functions of plastics.

"Elements of Physical Chemistry." Samuel Glasstone and David Lewis. D. van Nostrand Co., 120 Alexander St., Princeton, N. J. Cloth, 6 by 9¼ inches, 758 pages. $8.50.

Samuel Glasstone, a rather prolific writer of physical chemistry texts, and David Lewis have perhaps overestimated the ability of the chemistry student: they have labeled their comprehensive, rather difficult, and barely elementary volume an introductory one.

This revision of a 1946 edition starts out in chapter 2 with discussion of the gas laws and transcendental equations. Following this, the first two laws of thermodynamics are introduced, so that they may be applied to the successive material. The remainder of the 18 chapters cover all phases of physical chemistry. The appendices include tables of atomic weights, physical constants and conversion factors, and logarithms, as well as answers to the problems.

As might be expected after a break of 16 years, the authors have added much new material, including two chapters—Physical Properties and Molecular Structure, and Nuclear Chemistry. The problems have also been reworked.

Article Abstracts

Materials

"New Urethane Laminates Have Good Flexural Properties," A. P. Bonanni, MATERIALS DESIGN ENG., 53, 1, 9 (Jan. 1961).

Brief report on flexural properties of the new urethane laminates.

"What's Wrong with Data on Reinforced Plastics," Harry Raech, Jr., MATERIALS DESIGN ENG., 53, 5, 121 (May 1961).

A critical examination of standard mechanical tests being used today.

"Flexible Polyester-Liquid Epoxy Resin Condensates," John Wynstra, SPE J., 17, 5, 481 (May 1961).

Description of a method for evaluating the functionality of polyesters crosslinked with diepoxides.

"Effects of Basic Polymer Properties on Injection Molding Behavior," R. B. Staub, SPE J., 17, 4, 345 (April 1961).

An ANTEC paper showing that molding is affected by heating rate, polymer flow properties, mold temperature uniformity, polymer shear rate, and molecular orientation.

"Pitfalls in Predicting the Performance Characteristics of High Density Polyethylene," V. L. Folt & R. J. Ettinger, SPE J., 17, 4, 350 (April 1961).

An ANTEC paper describing a testing program for evaluating processing and tensile properties.

"Effect of Molding Conditions on Shrinkage of Modified Polystyrene," R. G. Hochschild, SPE J., 17, 4, 358 (April 1961).

An ANTEC paper studying effects of molding conditions on shrinkage.

"How to Choose the Right Fabric for the Job," S. J. Nichols, PROGRESSIVE PLASTICS, pg. 65 (May 1960).

Brief description of glass fabrics and their constructions.

"Electro-Thermal Analysis of Thermosetting Polymers," R. W. Warfield, SPE J., 17, 4, 364 (April 1961).

An ANTEC paper discussing the mechanism of degradation of complex polymers.

"Mechanisms of Stereospecific Polymerization of Dienes," C. E. H. Bawn, RUBBER & PLASTICS AGE, 42, 3, 267 (March 1961).

A paper presented originally at the 2nd International Synthetic Symposium last October.

"New Resins Need New Techniques," W. J. Cannon, PROGRESSIVE PLASTICS, pg. 23 (June 1960).

Review of new colorants and their uses in the newer plastics.

"Three Methods at Your Service," C. J. Harwick, PROGRESSIVE PLASTICS, pg. 39 (June 1960).

Brief descriptions of three methods for adding colorants to plastics.

"Polypropylene—A Survey of Its Properties and Newer Applications," J. I. G. Bell, PROGRESSIVE PLASTICS, pg. 31 (Oct. 1960).

Brief review of the subject.

"Designing Plastic Parts for Metallizing," Allen Shaw, MODERN PLASTICS, 38, 7, 114 (March 1961).

Points to consider for designers and molders.

"Progress in Reinforced Polyesters," G. Tolley, MODERN PLASTICS, 38, 7, 123 (March 1961).

Features of present usage of polyester resins in United Kingdom.

"Infra-Red Spectrum of Polyethylene," D. L. Wood & J. P. Luongo, MODERN PLASTICS, 38, 4, 132 (March 1961).

Review of current status of work on infra-red spectography.

"How to Determine Resin Cure," J. C. H. Chang, MODERN PLASTICS, 38, 8, 117 (April 1961).

A method for determining cure rate of phenolic-impregnated materials.

"Epoxidized Polyolefin Resins," C. W. Johnson & F. P. Greenspan, MODERN PLASTICS, 38, 8, 135 (April 1961).

A representative cure system for mechanical and electrical properties is described.

"Absorption of Polymers on Glass and Other Substrates—Part 1," R. R. Stromberg & G. M. Kline, MODERN PLASTICS, 38, 8, 123 (April 1961).

The first section of a two-part article.

"A Study of Curl in Decorative Laminates," W. E. Morris & J. M. Verdi, AUSTRALIAN PLASTICS, 16, 188, 13 (March 1961).

Problems relating to warping are discussed.

"New Controlled-Structure Polymers of Butadiene," W. W. Crouch, RUBBER & PLASTICS AGE, 42, 3, 276 (March 1961).

Another paper presented last October at the 2nd International Synthetic Symposium.

"Aging of Plastics from the Technical Viewpoint," W. Bauer, KUNSTSTOFFE, 51, 3, 133 (March 1961).

The effects of time on plastics materials are discussed. It is shown that aging constants cannot be fixed, but depend on end-use requirements.

"Glass Fiber Reinforced Plastics as Modelling Material in Photoelasticity," K. Muller, KUNSTSTOFFE, 51, 3, 135 (March 1961).

Suitable combinations of glass and synthetic resins can be used in photoelastic determinations.

"Structure, Reactions and Applicational Significance of Aldehyde Starch," P. J. Borchert, KUNSTSTOFFE, 51, 3, 137 (March 1961).

A report on a high polymer produced from a natural polymer by a simple chemical oxidation process.

"Optical Properties of Transparent Corrugated Sheets. Loss in Light Transmission Through Reflection," V. Zvonar, KUNSTSTOFFE, 51, 3, 145 (March 1961).

It is proved that light loss is determined not only by refractive index and angle of coincidence, but also by the actual form of the corrugated sheet.

"Dynamic Mechanical Testing of Polymers—Part 2," G. C. Karas & B. Waeburton, BRIT. PLASTICS, 34, 4, 189 (April 1961).

This part describes the salient features of some of the many techniques used in laboratories throughout the world for mechanical testing.

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in September. The last listing appeared in the May issue.

"Contribution to the Analytical Chemistry of Plastics. XII. Analysis of Cellulose Acetobutyrates. II," J. Franz, PLASTE U. KAUTSCHUK, 7, 10, 493 (Oct. 1960).

A mathematical method for determining acetic and butyric acids in cellulose acetobutyrates is checked which is based on the saponification number, the amount of acetobutyrate used in sapinification, and the amount of cellulose obtained during saponification. The method is found to be useful for calculating the two acids without separation and quantitative determination. (In German.)

"Blowing of Polyethylene Bottles—Effect of Material and Processing Conditions on Weight and Stress Cracking Resistance," W. R. K. Wilson, KUNSTSTOFFE, 51, 3, 158 (March 1961).

Based on many experiments, it is of considerable importance to have a ratio of at least 1.2:1 for bottom diameter of bottle: length of seam.

"Intramolecular Cyclization Reactions in Polymethyl Vinyl Ketones," R. Schulz, H. Vielhaber, and W. Kern, KUNSTSTOFFE, 50, 9, 500 (Sept. 1960).

The polymerization of methyl vinyl ketone by azo-iso butyric nitrile and the structure of the polymer are discussed. Conditions have been found under which intramolecular cyclization becomes the main reaction without cross-linking.

Equipment

"Molds for Plastisols," R. J. Jonke, IND. PLASTIQUES MOD., 13, 1, 37 (Jan.-Feb. 1961).

Description of the electroforming of molds, particularly for toys, to be produced from plastisols by rotational molding. (In French.)

"Problems of Sprue and Gating Techniques in Injection Molding of CA and CAB Compounds," L. Hille, PLASTVERARBEITER, 12, 1, 8 (Jan. 1961).

A number of examples illustrate the importance of correct designing of sprue and gating in the injection molding of CA and CAB compounds. As presently designed, the location of the cylinder in the axis of the machine often causes difficulties, and it is suggested that manufacturers of plastics machinery build a press permitting injection outside the machine's center so that large surfaces can be injected from the edge, without need for complicated molds. (In German.)

"Screw Presses in Injection Molding of Plastics," I. Ronzoni, POLIPLASTI, 8, 43, 28 (Nov.-Dec. 1960).

The principles of the method and design of machines are described and details are given of results of experiments in producing different articles from different kinds of materials. (In Italian.)

"A Huge Machine for Injection Molding of Thermoplastic Resins," M. Sirtoli, MATERIE PLASTICHE, 26, 12, 1160, (Dec. 1960).

The world's biggest injection molding machine, the first of a series of three 12,000-gram machines, has been delivered by Triulzi, Milan, to a German firm. Data for the machine are given, and it is noted that a 20-kg. (44 lbs.) machine is also planned. (In Italian.)

"Injection Molding Tool for Components with Internal Threads in Pairs," H. Gastrow, KUNSTSTOFFE, 51, 3, 163 (March 1961).

A brief note on subject tool.

"Wirecloth in the Rubber and Plastics Industries," W. A. Milliken, RUBBER & PLASTICS AGE, 42, 4, 388 (April 1961).

A general picture of usages for the metal screening.

Applications

"Plastics at the XII Trienial Exhibition at Milan," M. Parducci, MATERIE PLASTICHE, 26, 11, 1009 (Nov. 1960).

The theme of the Exhibition "House and School" indicates the trend of the chief applications of plastics shown. Among many interesting displays were: American experimental prefabricated house with walls of expanded polystyrene/aluminum sandwich; Japanese one-piece, stackable stools molded from colored polyester/glass material; Mexican rural school featuring polyester/glass class room walls, the movable upper panels of which have inserts of educational illustrations printed on translucent paper; French pre-fabricated panels of expanded polystyrene sandwiched between an outer aluminum skin and a veneer or plastic laminate, designed for rapid erection of schools of more than one floor; and kindergarten and primary school furniture of novel design from France, Belgium, Finland, and Germany. (In Italian.)

"Fibreglass in Aircraft and Missile Field," J. S. McBride, APPLIED PLASTICS, 4, 3, 66 (March 1961).

Review of applications and developments.

"Acrylic Emulsions in Water Paints," B. Barolo and W. Ghiglia, MATERIE PLASTICHE, 26, 11, 1050 (Nov. 1960).

The development in the United States, Italy, and Germany of water paints made with polymer binders is outlined; the properties (resistance to water, stability, sedimentation, tenacity, etc.) of acrylic emulsions are described and compared with those of emulsions of styrene butadiene and vinylaceto polymers and copolymers. (In Italian.)

"Metal-Bonding in the Construction of Electrical Machinery," H. Koinzack, PLASTE U. KAUTSCHUK, 7, 7, 334 (July 1960).

The bonding of a reinforcing paper laminate to a component made of an oxido-ceramin magnetic material, and gluing insulators in electrical machinery with epoxy resin adhesives, are described, as well as the use of epoxy resins in tool construction, to show how economies in materials and construction time can be effected by these means. (In German.)

"Polystyrene Caps," R. E. Pfister and J. W. Mighton, POLIPLASTI, 8, 41, 4 (July-Aug. 1960).

A description of the types of polystyrene suited for injection molded screw caps, is followed by pointers on a basic design applicable for all thermoplastic screw caps, as well as on the molding process itself and equipment. (In Italian.)

"Plastics in the Building Industry," L. Van Zetten, PLASTICA, 13, 8, 590 (Aug. 1960).

The author reports on the ways Shell Netherlands Refinery, at Pernis, has applied plastics for its own uses, e.g.: PVC pipe, couplings, ducting; epoxy resin/fiberglass armor for lead pipe; high pressure PVC pipe with expanded metal insert; PVC linings for steel pipe for conveying oil and salt solutions. He gives details of a method (patent applied for), of forming recesses in cast concrete structural parts with the aid of small PVC bags filled with wet sand. (In Dutch.)

Apparatus for Trimming Excess Plastic from Blown Plastic Articles. No. 2,943,349. E. L. Adams and R. C. Gasmire, Toledo, O. (to Owens-Illinois Glass Co.).

"Applications of Plastics in the Cable Industry in Australia," J. M. Wright, PRACTICAL PLASTICS, 11, 12, 17 (Dec. 1960).

A non-technical discussion of house and building wires and cables, aerial and overhead cables, underground cables, and other types of cables.

"Plastics for Building," D. G. Keith, AUSTRALIAN PLASTICS, 16, 185, 19 (Dec. 1960).

A survey of the utilization of plastics materials in building in Australia.

"Resins for Electronics," J. H. DuBois, PLASTICS WORLD, 19, 6, 46 (June 1961).

A brief review of applications resulting from material developments.

General

"Designers and Plastics Form a Dynamic Team for Industry," D. E. Scott, PROGRESSIVE PLASTICS, 9, 2, 50 (Sept. 1960).

A non-technical article stating that by detailed evaluation of contributing factors, the designer can perform an invaluable service in new applications.

CALENDAR of COMING EVENTS

September 3-8
American Chemical Society National Meeting. Chicago, Ill.

September 12
SPE Central Indiana Section RETEC. Plastics for Tooling. Hotel Severin, Indianapolis, Ind.

October 5
SPE Buffalo Section RETEC. Plastics Foams. Niagara Falls, N. Y.

October 9-11
TAPPI. Plastics-Paper Conference. French Lick-Sheraton Hotel, French Lick, Ind.

October 12-13
SPI New England Section Conference. Wentworth-by-the-Sea, Portsmouth, N. H.

October 16-19
TAPPI Engineering Conference. Economic Solutions through Engineering. Shoreham Hotel, Washington, D. C.

October 17-19
Plastics Show of Canada. Automotive Building, Exhibition Park, Toronto, Canada.

October 25
SPE Kentuckiana Section RETEC. Plastics in Major Household Appliances. Louisville, Ky.

November 2-3
SPE North Texas Section RETEC. Plastics in Packaging and Engineering Exhibition. Sheraton-Dallas Hotel, Dallas, Tex.

November 15
SPE New York Section RETEC. Vinyl Plastics in the Household. Statler-Hilton Hotel, New York, N. Y.

November 26-December 1
ASME Winter Annual Meeting. Statler-Hilton Hotel, New York, N. Y.

December 1
SPE Cleveland Section RETEC. Plastics Screw Injection Molding. Cleveland Engineering Society Building, Cleveland, O.

December 5-7
Building Research Institute 1961 Fall Conferences. Shoreham Hotel, Washington, D. C.

January 30-February 2
SPE 18th ANTEC. Penn-Sheraton Hotel, Pittsburgh, Pa.

February 6-8
SPE 17th Reinforced Plastics Division Conference. Edgewater Beach Hotel, Chicago, Ill.

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630 Third Avenue **New York 17, N.Y.**

Abstracts of Important Articles (Cont'd.)

"Melt Control in Screw Injection Machines," H. Goller, PLASTICS (LONDON, 26, 280, 89 (Feb. 1961.)
Description and analysis of the German-built injection machine.

"Risks of Testing Samples Selected at Random," K. C. J. B. Lind, PLASTICA, 13, 10, 908 (Oct. 1960).
The risks to supplier and consumer, involved in testing samples selected at random, can be accurately determined by statistical methods. Suggestions are offered for a more efficient system of sampling for testing rigid PVC pipe. (In Dutch.)

"Biological Deterioration of Plasticizers in PVC," E. H. Hueck-van der Plas, PLASTICA, 13, 12, 1216 (Dec. 1960).
The deterioration of plasticizers induced by microorganisms is reviewed and the comparative susceptibilities of a number of plasticizers are tabulated. (In Dutch.)

"Material Considerations in Construction with Plastics," C. M. V. Meysenbug, GUMMI ASBEST KUNSTSTOFFE, 14, 1, 26 and 14, 2, 114 (Jan. and Feb. 1961).
The peculiarities, advantages, and limitations of plastics as materials for industrial and other applications are compared with those of conventional materials. The need is stressed for designers of plastics articles to follow new directions, instead of imitating designs used for the older materials. (In German.)

"Injection Molding of Large Components," J. M. De Boissac, DIGEST MATIERES PLASTIQUES, 15, 109, 1 (Nov.-Dec., 1960).
General consideration of the technical problems involved in the injection molding of large parts, outlets for such components, and world trends in their production. (In French.)

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Domestic Production and Sales of Plastics and Resin Material, March and April, 1961

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of March and April, 1961. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

	March, 1961		April, 1961	
	Production	Sales	Production	Sales
Cellulose Plastics:				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,688,318	1,858,176	1,567,261	1,517,798
Sheets, 0.003 gage and over	1,889,593	2,066,795	1,744,492	1,689,425
All other sheets, rods, and tubes (including other cellulose plastics)	963,218	1,049,986	811,227	848,850
Molding and estrusion materials (including cellulose plastics)	7,569,494	7,391,862	7,057,471	6,695,806
Nitrocellulose sheets, rods, and tubes	94,244	111,605	88,031	82,426
TOTAL	12,204,867	12,478,424	11,298,482	10,834,305
Phenolic and Other Tar-Acid Resins:				
Molding materials	17,050,511	15,196,850	16,232,842	15,563,074
Bonding and adhesive resins for—				
Laminating (except plywood)	5,802,654	3,502,709	5,150,137	3,331,173
Coated and bonded abrasives	1,196,322	1,045,424	1,098,649	963,032
Friction materials (brake linings, clutch facings, and similar materials)	930,664	814,315	801,755	787,578
Thermal insulation (fiber glass, rock wool)	6,549,186	3,197,578	7,254,793	3,758,533
Plywood	6,077,967	5,270,725	5,716,830	4,446,328
All other bonding and adhesives uses	5,174,622	4,684,782	5,116,993	4,955,807
Protective-coating resins unmodified and modified except by rosin	1,793,585	1,171,263	1,504,289	1,263,085
Rosins for all other uses	3,529,542	3,259,873	3,766,351	3,753,405
TOTAL	48,005,053	38,143,519	46,642,639	38,822,015
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,543,345	2,463,829	2,033,635	2,004,334
Paper-treating and paper-coating resins	1,962,243	2,013,979	1,959,655	1,895,045
Bonding and adhesive resins for—				
Laminating	2,758,170	2,095,052	2,298,644	2,082,822
Plywood	7,261,494	7,007,816	6,779,498	6,998,034
All other bonding and adhesive uses	3,469,564	3,745,026	3,207,812	3,233,484
Protective-coating resins, straight and modified	2,810,964	1,937,294	2,952,221	1,973,032
Resins for all other uses, including molding	9,047,782	9,863,089	8,515,589	8,210,496
TOTAL	29,853,562	29,126,085	27,747,054	26,407,247
Styrene Resins:				
Molding and extrusion materials:				
Straight polystyrene	21,738,280	20,975,875	23,796,193	20,639,394
All other	28,992,996	33,328,455	33,805,514	29,945,889
Protective-coatings	6,536,211	5,367,546	5,062,434	4,062,071
Textile and paper treating and coating resins	6,822,125	4,907,368	8,201,998	6,081,307
All other uses	14,246,797	21,155,946	13,652,372	17,469,880
TOTAL	78,336,409	85,735,190	84,518,511	78,198,541
Vinyl and Vinyl Chloride Resins:				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		8,905,355		7,437,908
Sheeting (resin content)		9,036,080		10,134,644
Molding and extrusion (resin content)		24,779,753		23,058,700
Textile and paper treating and coating (resin content)		4,942,797		5,237,039
Flooring (resin content)		14,886,891		15,574,880
Protective coating (resin content)		3,088,556		2,943,004
All other uses (resin content)		11,406,830		11,134,304
All other vinyl resins for—				
Adhesives (resin content)		5,683,283		5,186,876
Protective coatings (resin content)		2,326,742		2,210,797
All other uses (resin content)		10,020,063		10,455,448
TOTAL	93,058,790	95,076,350	97,540,539	93,373,600
Coumarone-Indene and Petroleum Polymer Resins	17,295,221	17,530,596	17,297,719	16,896,685
Polyester Resins:				
For reinforced plastics	11,705,458	10,499,055	11,290,554	12,542,836
For all other uses	2,400,552	2,273,310	2,294,580	1,848,778
TOTAL	14,106,010	12,772,365	13,585,124	14,381,614
Polyethylene Resins:				
For film and sheeting		41,179,312		40,758,509
Molding materials		18,409,475		18,421,565
Extrusion materials		14,213,648		15,350,779
For all other uses		45,127,122		48,498,205
TOTAL	129,264,291	119,028,557[1]	124,858,789[2]	123,029,058[3]
Polypropylene Resins:	7,630,570	4,484,136	8,669,114	5,080,682
Epoxy Resins:				
For protective coatings		2,125,804		1,866,143
For all other uses		2,658,847		2,540,403
TOTAL	5,155,367	4,748,651	6,270,406	4,406,546
Silicone Resins		494,335		470,474
Miscellaneous Synthetic Plastics and Resin Materials	23,073,584	21,050,154	23,567,187	19,936,862
GRAND TOTALS	457,983,724	440,704,362	462,095,564	431,837,629

[1] 19.4% produced by the low-pressure process.
[2] 19.2% produced by the low-pressure process.
[3] 18.1% produced by the low-pressure process.
SOURCE: United States Tariff Commission Chemical Division.

Current Market Prices

Prices in general are f.o.b. works. Ranges indicates variations in grade, quality, quantities, and geographical locations of customers. No guarantee of these prices is made, and spot prices should be obtained by contacting this publication.

Catalysts

Ammonium thiocyanate	lb.	$0.1725	$0.26
Peroxide, acetyl, 25% in DMP	lb.	1.75	4.00
Benzoyl, dry, 96%	lb.	.88	2.00
Paste	lb.	.91	2.25
Wet, 50% paste in TCP	lb.	.89	2.25
In silicone fluid	lb.	2.75	4.25
In BBP	lb.	3.00	4.25
Caprylyl, liquid, 50% in mineral oil	lb.	4.45	5.00
In DOP		5.00	
Cyclohexanone, 45% paste in DBP	lb.	3.00	4.00
Powder, 85%, in DBP	lb.	2.00	3.00
p-Cyclobenzoyl, paste, 50%			
In mineral oil	lb.	4.25	5.00
In TCP	lb.	5.00	
2,4-Dichlorobenzoyl, 50%			
In silicone oil	lb.	4.25	5.00
40% in silicone oil	lb.	5.00	
Di-t-butyl	lb.	1.75	4.00
Other peroxides	lb.	2.05	5.00

Colorants

Black, std.	lb.	.90	4.10
Gel coats	lb.	.61	.86
Carbon black	lb.	.0575	.87
Paste	lb.	.65	.74
Bone blacks	lb.	.155	.2775
Iron oxide	lb.	.1275	.23
Lampblack	lb.	.1225	.175
Masterbatch	lb.	.60	.63
Paste (for epoxies)	lb.	1.58	2.15
(for vinyls)	lb.	.50	.66
Paste dispersion	lb.	.85	1.90
Paste concentrate	lb.	.82	1.20
Pigment dispersion	lb.	.83	1.15
Colloidal dispersions	lb.	.66	1.45
Aqueous	lb.	.115	.395
Blue, std.	lb.	.90	2.75
Concentrate	lb.	.95	3.00
Masterbatch	lb.	.85	1.13
Pearl	lb.	1.38	
Metallic	lb.	.02	
Paste (for epoxies)	lb.	1.25	2.60
(for vinyls)	lb.	.62	1.84
Paste dispersion	lb.	.85	2.40
Paste concentrate	lb.	.78	.80
Phosphorescent	lb.	.24	
Brown, std.	lb.	.87	4.00
Copper tinsel	lb.	.10	
Gel coats	lb.	.59	1.04
Iron oxide	lb.	.15	.24
Metallic bronze	lb.	.02	
Paste (for epoxies)	lb.	1.18	1.47
(for vinyls)	lb.	.48	1.67
Paste dispersions	lb.	.75	1.70
Paste concentrate	lb.	.65	2.30
Gold, metallic	lb.	.21	
Paste dispersions	lb.	1.40	1.60
Tinsels	lb.	.10	
Gray, gel coat	lb.	.59	.84
Paste (for epoxies)	lb.	1.40	
Paste dispersion	lb.	1.45	2.20
Green, std.	lb.	.90	3.25
Pearl	lb.	.10	
Concentrate	lb.	.95	3.00
Metallic	lb.	.21	
Phosphorescent	lb.	.24	
Masterbatch	lb.	1.20	1.23
Paste (for epoxies)	lb.	2.86	
(for vinyls)	lb.	.80	1.83
Paste dispersions	lb.	.85	2.70
Paste concentrate	lb.	.80	2.15
Chromic oxide	lb.	.45	1.40
Orange, dry	lb.	.49	3.50
Gel coat	lb.	.75	1.05
Lithopone	lb.	1.63	1.86
Paste (for epoxies)	lb.	1.58	
(for vinyls)	lb.	.74	4.27
Paste dispersion	lb.	.55	2.80
Paste concentrate	lb.	1.58	
Purple, pearl	lb.	.10	
Red, std.	lb.	.1425	5.00
Cadium lithopone	lb.	1.90	2.86
Selenide	lb.	4.60	7.15
Concentrate	lb.	2.25	2.50
Iron oxide	lb.	.0475	.205
Metallic	lb.	.021	
Masterbatch	lb.	.75	.88
Paste (for epoxies)	lb.	2.35	3.77
(for vinyls)	lb.	1.20	3.82
Paste dispersions	lb.	.90	3.05
Paste concentrate	lb.	5.42	6.49
Venetian	lb.	.065	.1325
Silver, metallic	lb.	.0165	
Paste (for epoxies)	lb.	1.55	
(for vinyls)	lb.	.89	.91
Paste dispersion	lb.	$0.85	$1.45
Paste concentrate	lb.	1.02	
Tinsels	lb.	.10	
Yellow, std.	lb.	.12	3.50
Cadium lithopone	lb.	1.21	1.29
Gel coat	lb.	.61	1.03
Masterbatch	lb.	.90	.93
Concentrate	lb.	1.00	2.50
Iron oxide	lb.	.1225	.1875
Paste (for epoxies)	lb.	2.15	2.55
(for vinyls)	lb.	.58	3.70
Paste dispersions	lb.	.90	2.20
Paste concentrate	lb.	.65	2.87
White, std.	lb.	.54	4.00
Concentrate	lb.	.70	1.25
Gel coat	lb.	.59	.84
Masterbatch	lb.	.75	.80
Paste (for epoxies)	lb.	1.02	
(for vinyls)	lb.	.48	.60
Pearl	lb.	.10	
Paste dispersion	lb.	.70	2.00
Paste concentrate	lb.	.705	.725

Fillers

Aluminum silicate pigments	ton	21.50	65.00
Barytes	ton	60.00	123.00
Paste concentrate	lb.	.705	.725
Calcium carbonate, ppt.	ton	30.00	187.00
Std.	ton	15.00	35.00
China clay	ton	40.00	
Flours	ton	50.00	106.00
Flocks, cotton	lb.	.12	.30
Rayon	lb.	.50	1.25
Nylon	lb.	.35	2.75
Mica	lb.	.075	4.44
Silica	ton	25.00	48.50
Whiting	ton	8.75	13.25
Oyster shell	lb.	30.00	
Wollastonite	ton	29.00	47.50

Miscellaneous

Anti-Fog	gal.	8.69	16.95
Anti-Static	gal.	3.57	8.50
(for films)	gal.	8.00	8.50
Odorants	lb.	1.25	10.00
Purging cmpd. (for injection)	lb.	.40	
Wetting agent (for dry coloring)	gal.	2.50	3.20
(for wet operations)	lb.	2.59	3.69

Mold Release Agents

Silicone type: Cmpds	lb.	4.70	5.20
Aerosols, 20 oz. can		.80	1.00
Emulsions	lb.	1.09	1.65
Fluids	lb.	2.74	6.00
Solvent emulsions	lb.	.40	4.95
Stearates: Barium	lb.	.41	.46
Calcium	lb.	.39	.44
Magnesium	lb.	.42	.47
Zinc	lb.	.41	.48

Plasticizers

Adipate, Butyl Cellosolve	lb.	.45	.47
Didecyl	lb.	.265	.375
Dihutoxyethyl	lb.	.425	.46
Diisodecyl	lb.	.40	.44
Diisobutyl	lb.	.41	.44
Dioctyl	lb.	.36	.535
Diisooctyl	lb.	.36	.435
2-ethyl hexyl	lb.	.36	.435
Isooctylisodecyl	lb.	.40	.435
Isooctyl	lb.	.49	.535
n-Octyl decyl	lb.	.36	.44
Azelate, dioctyl	lb.	.41	.49
Di-2-ethyl hexyl	lb.	.40	.465
Dibenzoate, Diethylene glycol	lb.	.285	
Dipropylene glycol	lb.	.285	
Diethylene glycol	lb.	.45	.60
Triethylene glycol	lb.	.60	
Epoxy, polymeric	lb.	.3225	.3525
Monomeric	lb.	.3475	.3775
Ester, Fatty Acid	lb.	.3525	.3775
Monomeric	lb.	.35	.60
Laurate, Butoxyethyl	lb.	.39	.40
Oleate, Butyl	lb.	.24	.33
Butoxyethyl	lb.	.30	.33
Methoxyethyl	lb.	.31	.34
Phosphate, Tributyl	lb.	.50	.535
Tricresyl	lb.	.325	.36
Phthalate, Butyl Cellosolve	lb.	.35	.385
Butyl octyl	lb.	x .255	$ .30
Cyclohexyl	lb.	.265	.305
Isodecyl	lb.	$0.26	$0.30
Butoxyethyl	lb.	.365	.375
Dibutyl	lb.	.285	.43
Dicaprvl	lb.	.265	.445
Dicyclohexyl	lb.	.40	.595
Didecyl	lb.	.27	
Diisodecyl	lb.	.28	.45
Diisooctyl	lb.	.26	.445
Dioctyl	lb.	.215	.305
Isooctyldecyl	lb.	.27	.45
Methoxyethyl	lb.	.355	.405
Polyester type	lb.	.34	.7125
Polymeric type	lb.	.39	.93
High-solvating	lb.	.37	.425
Ricinoleate type	lb.	.32	.35
Sebacate, Dibenzyl	lb.	.91	1.04
Dibutyl	lb.	.655	.745
Dioctyl	lb.	.57	.6825
Soy Bean oil, epoxized	lb.	.3235	.4775
Stearate, Butyl	lb.	.235	.295
Butoxyethyl	lb.	.31	.32
Epoxized octyl	lb.	.3475	.5325
Methoxyethyl	lb.	.32	.35
Octyl epoxy	lb.	.3925	.447
Tallate, Octyl epoxy	lb.	.3475	4.025

Resins, Molding, Casting & Coating

ABS type	lb.	.44	1.05
Acetal	lb.	.65	.93
Colors	lb.	.74	1.24
Acrylic	lb.	.46	1.08
Alkyd	lb.	.1325	1.20
Allyl (diallyl phthalate)	lb.	.95	2.50
Carbonate	lb.	1.30	2.25
Cellulosics:			
Cellulose acetate	lb.	.35	.68
Reprocessed	lb.	.25	.36
Cellulose acetate-butyrate	lb.	.40	.81
Reprocessed	lb.	.35	.45
Cellulose propionate	lb.	.40	.81
Ethyl cellulose	lb.	.67	
Reprocessed	lb.	.30	
Epoxy, liquid	lb.	.60	1.41
Solid	lb.	.51	1.31
Ethylene copolymers	lb.	.32	.95
Fluorocarbons	lb.	3.25	11.00
Furane	lb.	.75	1.00
Liquid	lb.	.32	.44
Melamine	lb.	.57	.70
Coating solns.	lb.	.3275	.4375
Phenolic	lb.	.207	1.12
Coating solns.	lb.	.305	.3525
Polyamide	lb.	.62	1.26
Coatings	lb.	.61	1.51
Graphite-filled	lb.	1.40	1.83
Heat-stabilized	lb.	1.09	1.55
Molybdenum sulfide-filled	lb.	1.19	2.07
Polycarbonate	lb.	1.30	2.29
Polyester, powder	lb.	.26	2.20
Coating	lb.	.0975	.1275
Glass-reinforced	lb.	.41	.80
Polyethylene, low-density	lb.	.2375	.615
Medium-density	lb.	.2375	.6425
High-density	lb.	.275	1.59
Polypropylene	lb.	.42	1.17
Reprocessed	lb.	.50	
Polystyrene	lb.	.18	1.34
Reprocessed	lb.	.15	.26
Rubber-modified	lb.	.20	.275
Polyurethane	lb.	1.30	7.50
Silicones, casting	lb.	7.50	11.40
Molding	lb.	2.40	3.55
Urea coating solns.	lb.	.205	.27
Vinyl, dispersion grade	lb.	.24	.325
Copolymers	lb.	.2025	.44
Molding	lb.	.185	.66
Nitrile rubber blend	lb.	.45	.53
Reprocessed	lb.	.19	.22
Vinyl-vinylidene copolymer	lb.	.185	.32
Vinylidene	lb.	.205	6.00
Latex	lb.	.45	.52

Solvents

Ketones: Acetate	lb.	.08	.22
Methyl isoamyl	lb.	.175	.315
Esters: Ethyl acetate	lb.	.125	.2675
Isopropyl acetate	lb.	.115	.255
n-Butyl acetate	lb.	.145	.285
Alcohols: Isobutyl	lb.	.13	.27
n-Butyl	lb.	.155	.295

Stabilizers

Alkyd tin mercaptide, liq.	lb.	2.50	3.15
Barium-cadmium complex:			
liquid	lb.	.50	.585
Solid	lb.	.97	1.25
Barium-cadmium laurate	lb.	.87	.90
Myristate	lb.	.72	.75
Barium-cadmium-zinc complex	lb.	.54	.56
Barium-zinc, liquid	lb.	.58	.615
Powder	lb.	.375	.44
Complex	lb.	.47	.50
Cadmium-barium, powder	lb.	.68	.895
Chelating agent, liquid	lb.	.57	.84
Cadmium-containing	lb.	.84	.87
Zinc-containing	lb.	.62	.80
Organic complex, liquid	lb.	.57	.845
Strontium-zinc laurate	lb.	.72	.75
Zinc, liquid	lb.	.48	.52

advertisers' index

key no.		page no.
99	American Cyanamid Co. (Plastics & Resins Div.)	1
106	Barber-Colman Co. (Wheelco Instruments Div.)	9
108	D-M-E Corporation	12
118	Emery Industries, Inc.	54-55
109	Farrell-Birmingham Co., Inc.	13
117	Foster Grant Company, Inc. (Polymer Sales Div.)	48-49
104	General Color Co. (Div. of H. Kohnstamm Inc. & Co.)	8
100	W. R. Grace & Co. (Polymer Chemical Div.)	3
107	Goodrich-Gulf Chemicals, Inc.	10-11
125	The Harshaw Chemical Co.	Fourth Cover
98	Harchem Division of Wallace & Tiernan, Inc.	Second Cover
116	Hercules Powder Co. (Plastics Div.)	24
105	Hobbs Mfg. Co.	8
113	Improved Machinery, Inc.	19
120	Injection Molders Supply	59
124	Marbon Chemical Division (Borg-Warner Corp.)	Third Cover
114	Monsanto Chemical Co. (Organic Div.)	20-21
110	National Lead Co. (Chemical Div.)	15
111	Chas. Pfizer & Co. (Industrial Div.)	16
101	Plastics Engineering Co.	5
123	Rogers Hydraulics, Inc.	63
121	Rubber Latex Co. of America	62
126	Rubber World	64-65
102	Francis Shaw & Co. Ltd.	6
112	J. F. Stokes Corp.	18
122	TEC Extruder	62
115	Union Carbide Plastics Co.	22-23
103	U.S. Industrial Chemicals Co.	7
119	Weldotron Corp.	59

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159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178
179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198
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159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178
179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198
199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218
219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238

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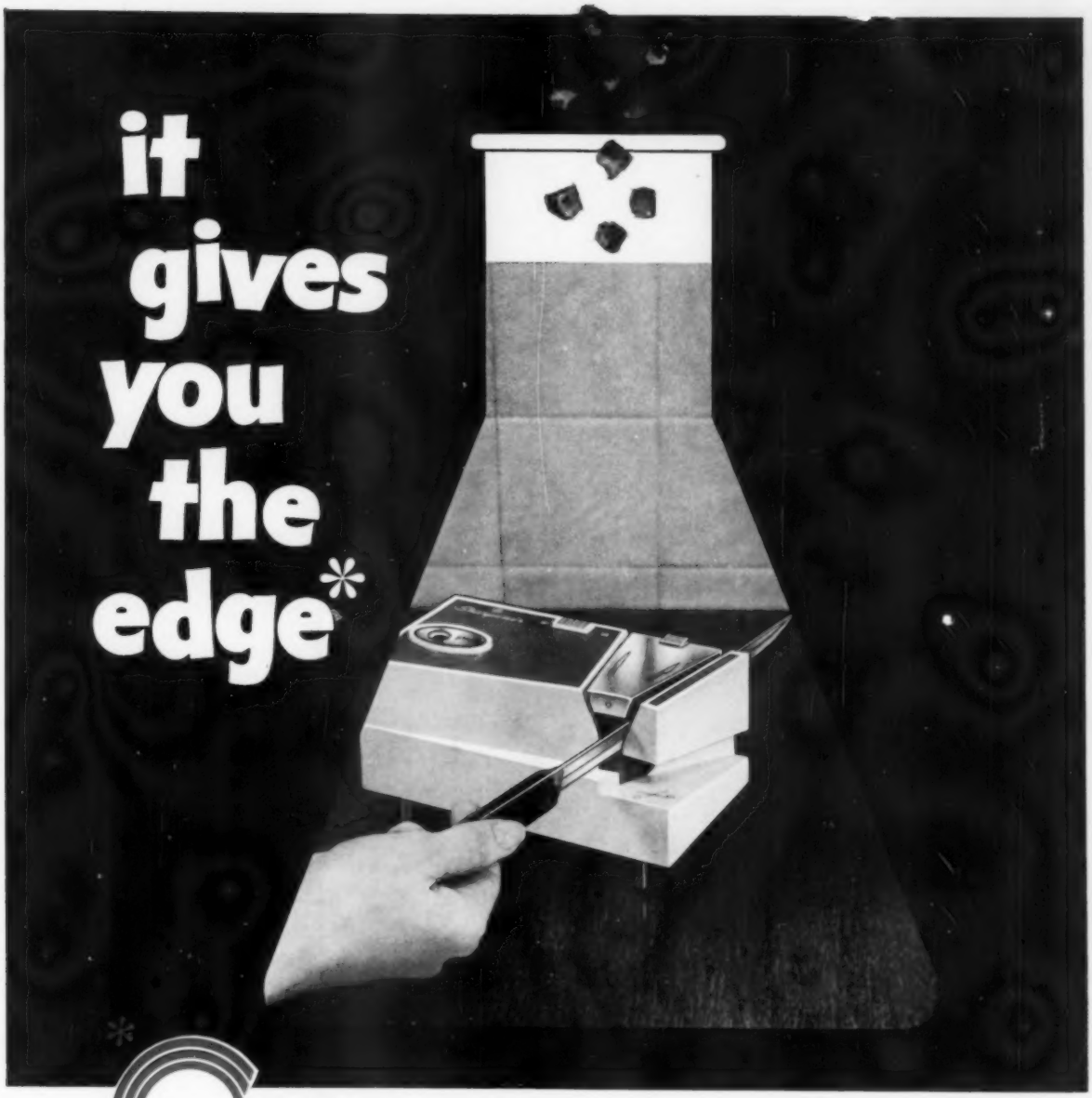

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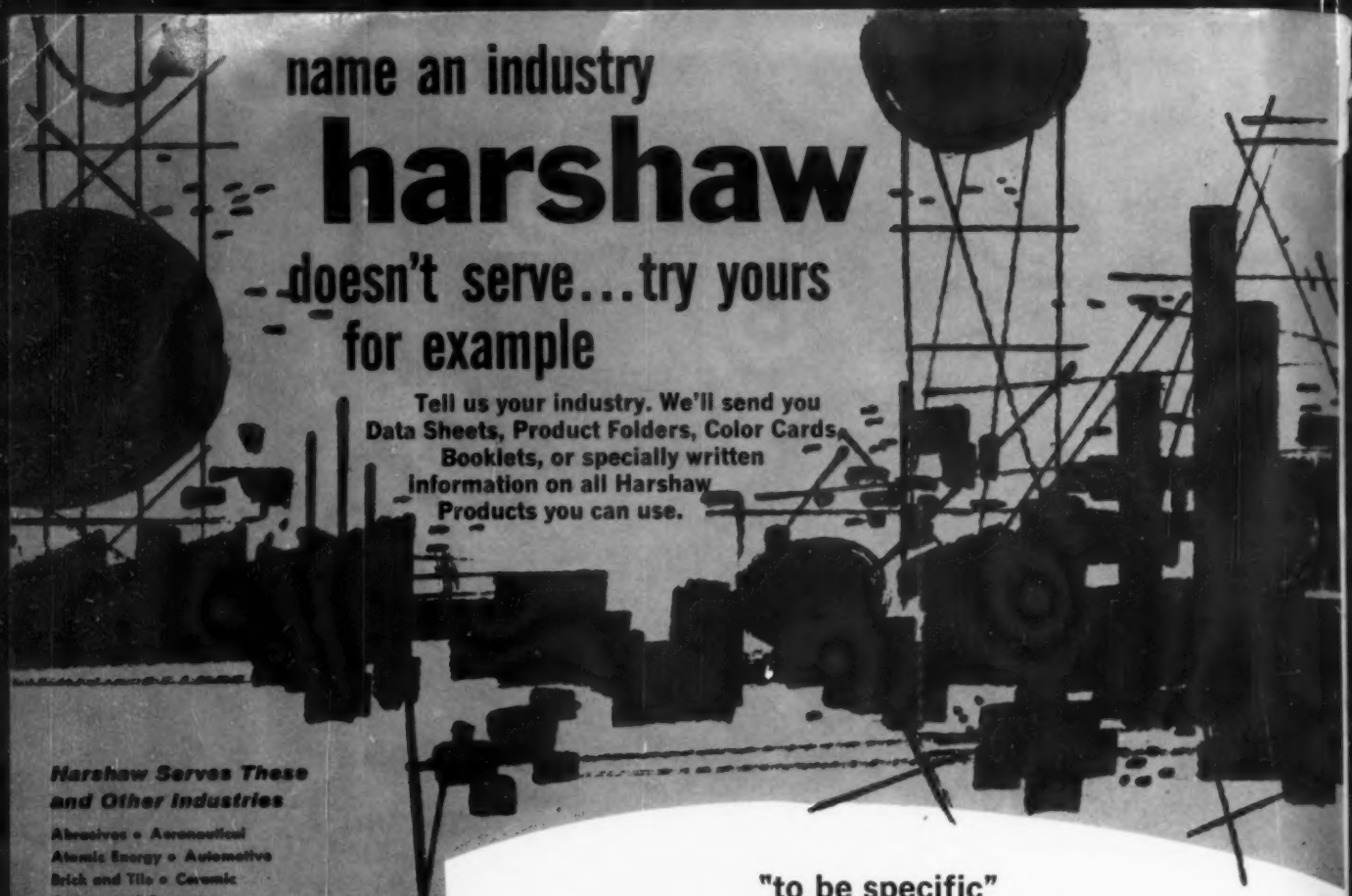

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